# MECHANICAL ENGINEERING

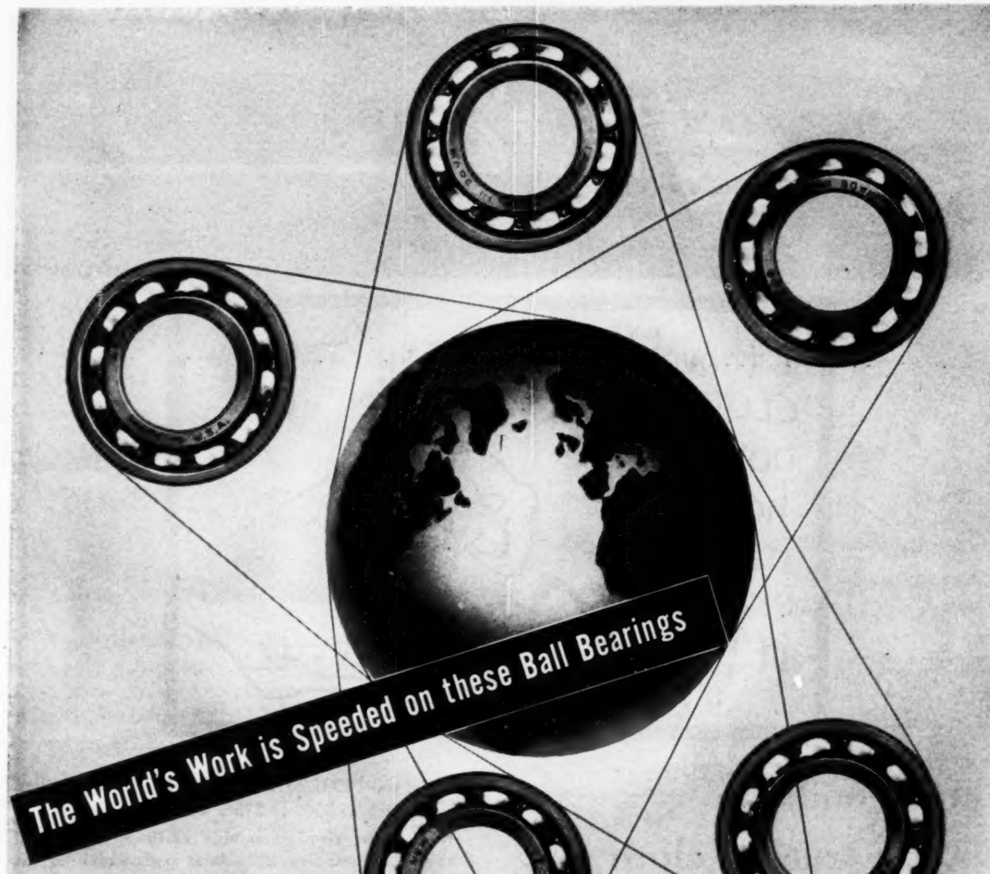
· OCTOBER 1951 ·



**Departments**



**Tentative Program — ASME 1951 Annual Meeting — See pages 854-860**

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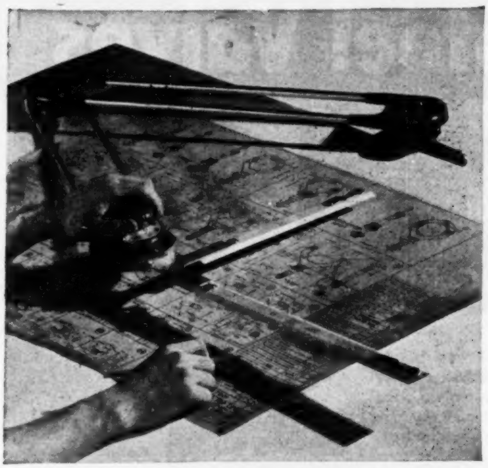

[redacted]

You wouldn't try to be Rachmaninoff without a piano, or a Kreisler without a fiddle. Well, who would want to be a draftsman without a K&E PARAGON† DRAFTING MACHINE?

This miracle machine makes you a veritable orchestra leader at your drawing board. It combines T-squares, triangles, protractors and scales, all in one unit, controlled entirely by one hand.

You can move a rule all over the board, and the rule stays parallel to its original position. You can draw all lines to exact length. The lightest touch rotates the scales to any angle desired.

[redacted]

Permanent accuracy is assured, because the open center arm construction makes it practically impossible to disturb the factory-set band tension.

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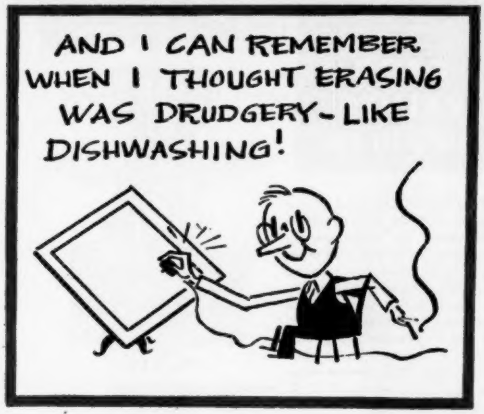


This K&E MOTORASER* makes old-fashioned hand erasing look horse and buggy. It reduces your erasing time to seconds.

Since it depends on speed rather than pressure, the MOTORASER does not wear holes in paper. It's as accurate as a pencil point, yet will clean large areas in a jiffy.

It's handy in the hand—a 3 inch palm full with a finger-tip switch—only 6 oz. Uses AC juice —60 cycle 110 volt AC—or DC with an inexpensive adapter. A sturdy little feller, too.

*Trade Mark

For further information about any of the above products, ask a K&E Distributor or any K&E Branch, or write to Keuffel & Esser Co., Hoboken, N. J.

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partners in creating
For 83 years K&E equipment and materials have been partners of the draftsman, engineer and scientist in shaping the modern world.

[redacted]

# Select Your Steel Valves

Edward
**GAGE VALVES**
**600 lb sp**

Fig. 152

**FIG. 152 SERIES**—A drop forged, instead of bar stock, steel valve for gage, meter, dead-end, instrument and other small lines, and for pumps, vents, Diesel and gas engines, etc. Long taper semi-needle type stem-disk for close regulation and tight seating. Fig. 152 series has carbon steel body with EValloy 13% chrome stem-disk. Fig. 2152 series, all 13% chromium stainless steel. Fig. 4152 series, all 18-8 stainless steel.

Screwed Ends—Globe or Angle

Size Range—⅛", ¼", ⅜", ½", ¾" and 1"

Edward
**Globe & Angle Valves**
**600-1500 lb sp**

Fig. 444-944

**FIG. 444-944 SERIES**—All purpose valves, ideal for nearly any service where O. S. & Y. small forged steel valves are used. Streamlined, low-pressure loss body and bonnet both forged steel. Built with union bonnet in sizes 1" and smaller for 600 lb sp, and in sizes ¾" and smaller for 1500 lb sp. Larger sizes in both pressure classes have bolted bonnet joint. Bronze bushed yoke, simplified bolted gland design for easy packing adjustment, EValpak high pressure-high temperature die-molded packing, and inclined stem design for free flow and minimized turbulence are standard features. Easy to repack, with both hands free to insert packing. Stem, disk and seat hardened EValloy 13% chromium stainless steel regularly furnished; Stellite hard-faced seat and disk available on order.

Fig. 448-948

Screwed or Socket Welding Ends—O. S. & Y —Globe or Angle

Size Range—¼", ⅜", ½", ¾", 1", 1¼", 1½" and 2"

Edward
**INSTRUMENT VALVES**
**1500 lb sp**

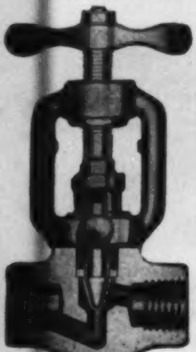


Fig. 952

**FIG. 952 SERIES**—A compact, heavy-duty valve for instrument panels, regulators, orifice meters, by-pass lines, oil field gage or instrument services, corrosive lines, etc. Drop forged steel body and yoke. No possibility of bonnet joint leakage. Swing bolted gland. Fig. 952 series valves have carbon steel body with EValloy 13% chromium stainless steel trim. Fig. 2952 series has EValloy stainless steel body and trim.

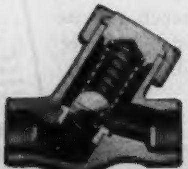
Screwed or Socket Welding Ends—O. S. & Y.—Globe or Angle

Size Range—¼", ⅜", ½"

Edward
**CHECK VALVES**
**600-1500 lb sp**

**WIDE CHOICE**

Edward forged steel check valves are built in ball or piston types, with union or bolted bonnets, with screwed, socket welding or flanged ends. Available for installation in either horizontal or vertical lines.

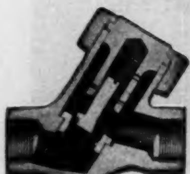


**BALL CHECKS**

Ideal for viscous fluid service. Spring loaded, fully guided ball disk is stainless steel, as is the mated seat.

Screwed or Socket Welding Ends—Horizontal or Vertical.

Size Range—¼", ⅜", ½", ¾", 1", 1¼", 1½" and 2".

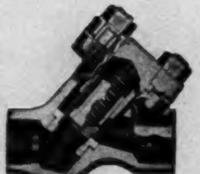


**PISTON CHECKS**

General service small check valves that give freedom from shock or excessive vibration, yet seat quickly and tightly upon flow reversal.

Screwed, Socket Welding or Flanged Ends—Horizontal or Vertical.

Size Range—¼", ⅜", ½", ¾", 1", 1¼", 1½" and 2".

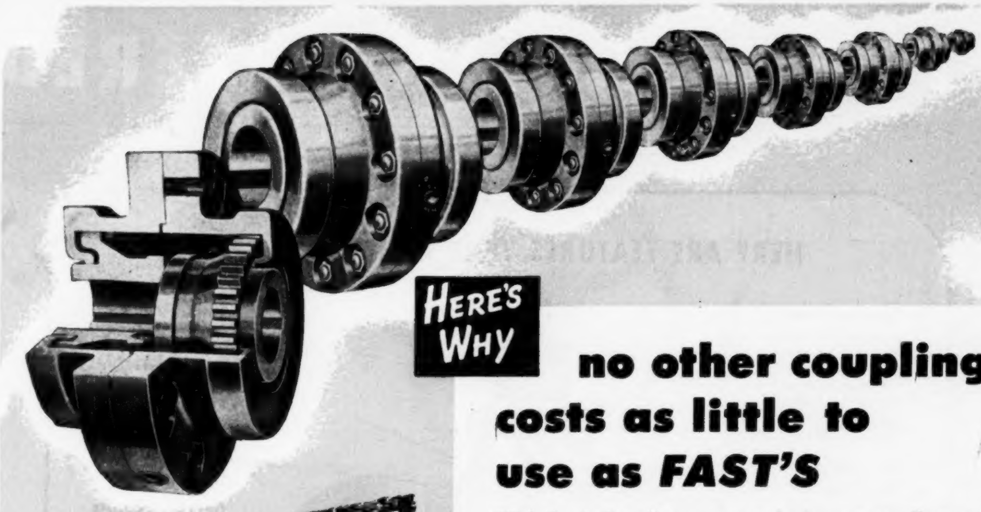


**BOLTED COVER CHECKS**

Either ball or piston types, in variations of body style and end connections for boiler feedline or general process services.

Screwed, Socket Welding or Flanged Ends—Horizontal, Vertical or Angle.

Size Range—½", ¾", 1", 1¼", 1½" and 2".



**HERE'S WHY**

# no other coupling costs as little to use as *FAST'S*

With Fast's Couplings you get the lowest coupling cost per year that modern engineering can provide—*because Fast's normally outlast the equipment they connect.* That means their cost can be spread out over 20 years or more!

As two users recently said:

*"We've had this Fast's Coupling since 1930 . . . and it's apparently going to last forever.* [*Wish*] *the other equipment caused as little trouble!"* . . . *"We have two Fast's Couplings . . . they are the only equipment so trouble-free we long ago forgot we had them!"*

If you want lower costs, freedom from coupling shutdowns and dependable coupling engineering—specify Fast's. For complete details, mail the coupon for Fast's free catalog. Do it today!

## RUGGED CONSTRUCTION:

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**Couplings**

**INDUSTRY'S STANDARD FOR 31 YEARS**

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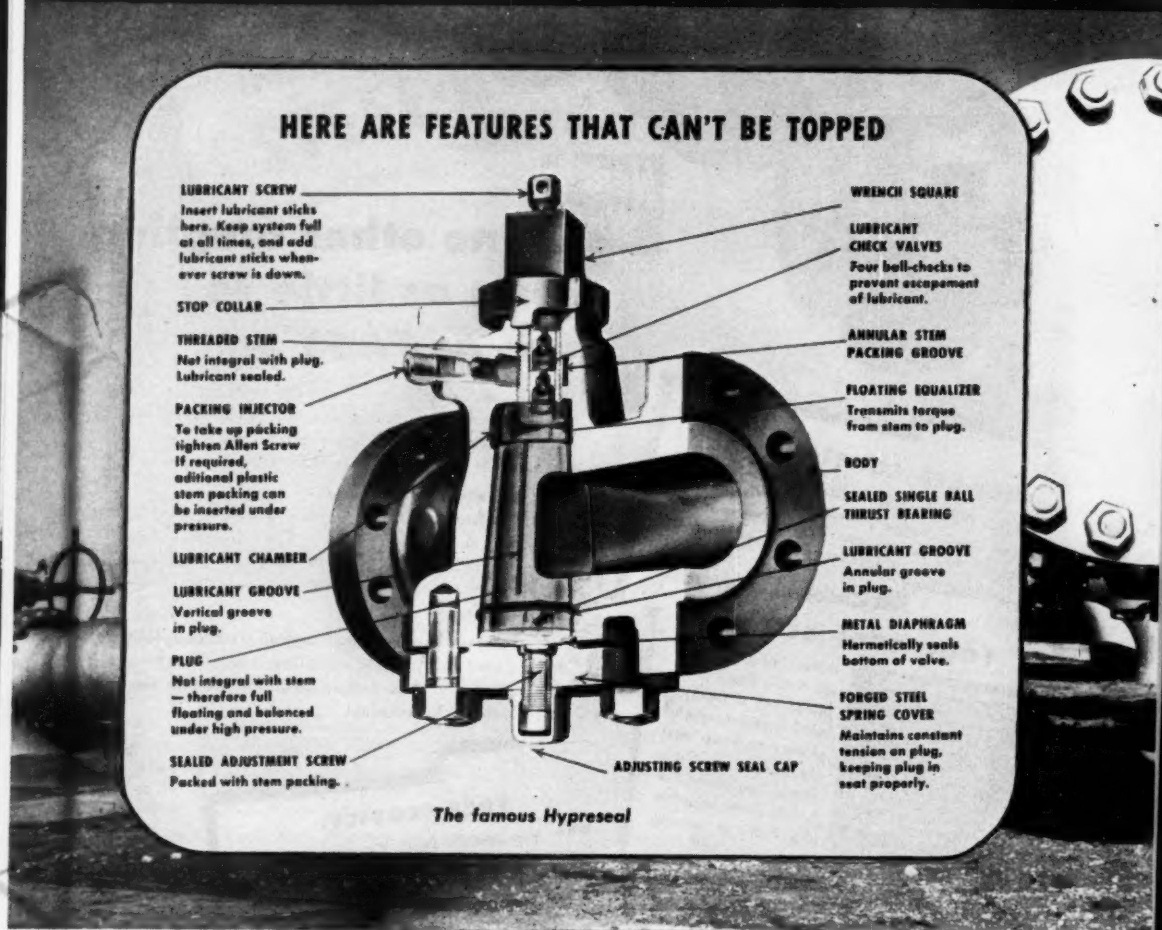


*The famous Hypreseal*

## Every feature points to safety and dependability

You get advantages in Nordstrom valves that have proved dependable for more than 25 years of service. The Hypreseal type, for high pressures, offers a score of finely engineered features. Here is precision line control at its best for the rugged duty imposed in cross country pipe line transmission as well as for positive control in plant operations. Installing Nordstrom valves for replacement of all your troublesome valves progressively reconditions your equipment to a higher level of safety, fewer repairs, less frequent line interruptions and saving in maintenance costs. ***Keep upkeep down . . . WITH NORDSTROMS***

. . . for rugged duty
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Nordstrom
Pats. Applied for
VALVES... NOW AUTOMATICALLY LUBRICATED WITH Hypermatic
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## the **engineered** way to put an end to a pressure problem

WHEN IT COMES to containing pressures—in a header or pressure vessel or in merely blanking off a line—your safest, surest bet is a TUBE-TURN Welding Cap. Formed to 2:1 semi-ellipsoidal contours, it represents the ideal pressure-resisting closure for a cylinder. No makeshift capping method can approach its bursting strength which is actually far greater than seamless tubing of like thickness and grade of steel.

Another important point: TUBE-TURN Welding Caps are manufactured to meet ASME Boiler Code requirements and the chemical-physical standards of ASTM specification A106 for Grade A and Grade B carbon steels.

For welding caps and for all TUBE-TURN Welding Fittings and Flanges, see your nearby TUBE TURNS' Distributor. You'll find one in every principal city.

**Write Dept. F-10 for free booklet giving Dimensional Data on types, sizes and materials of TUBE-TURN Welding Fittings and Flanges.**

*"Be sure you see the double tt*

# TUBE TURNS, INC. LOUISVILLE 1, KENTUCKY

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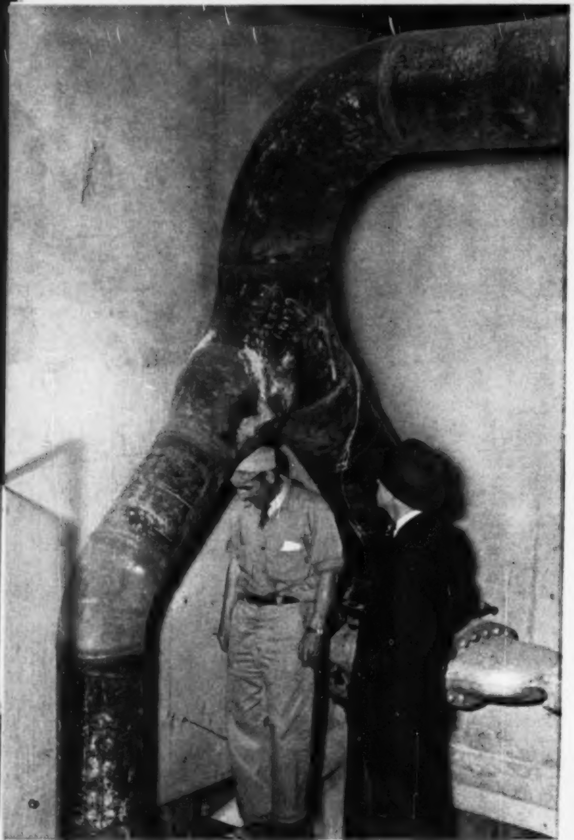

Here the 18" steam main from the power plant leads to a fabricated "Y" connection, then through tunnels to foundry and engine shop. One side is stepped down through a TUBE-TURN Welding Reducer to a 16" line; the other side through another TUBE-TURN Welding Reducer to a 12" line. Special "Y" connection was made by cutting and welding two 45° Welding Elbows, a job that calls for uniform wall thickness and concentricity throughout the fittings—a point of pride with TUBE TURNS, INC.

**Want Dimension Data?**

Tube Turns, Inc. has compiled a handy folder of charts covering dimensions and weights of TUBE-TURN Welding Fittings and Flanges. If you'd like a free copy just send this coupon.

TUBE TURNS, INC., Dept. F-10
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*Position* ..............................................

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*Nature of Business* ..............................................

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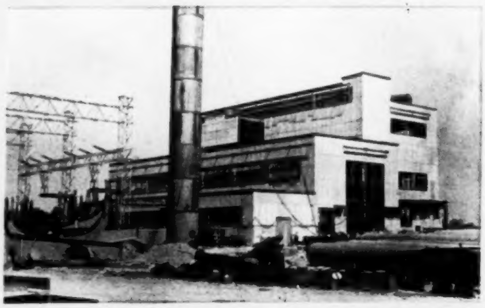
# New Ford Power Plant features welded piping



**Power station for Ford Motor Company's giant new engine plant and foundry, now being built in Cleveland; F. A. Fairbrother—Geo. H. Miehls, Architect and Engineer; Albert Kahn Associates, Consultants. Engine plant will be equipped with the last word in automatic machinery—to save production man-hours. The designers believe in saving maintenance man-hours too. Thus at the power plant, which will supply 360,000 pounds of 150-lb. steam per hour for heating and process, an all-welded piping system with TUBE-TURN Welding Fittings and Flanges was specified. Welded steam, air, and condensate lines are permanent and leakproof.**

In engine shop, smaller lines designed to carry coolant oil to machine tools are also welded. Wide range of TUBE-TURN Welding Fittings and Flanges—including more than 4000 different items—simplifies installation job. Leakproof piping will free maintenance personnel for other work.

Despite close quarters in tunnel, fabrication goes ahead swiftly. Welders and contractors like to use TUBE-TURN Welding Fittings because they know that dimensions are always accurate, thus line-up is easy. Welded lines can be fitted closely together, will make for a neat installation. With no flanges to work around, insulation can be applied easily.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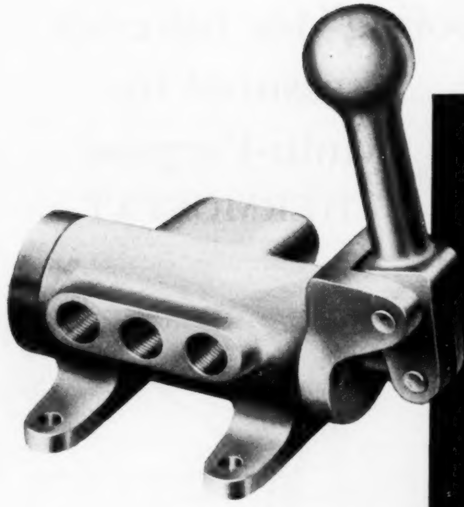
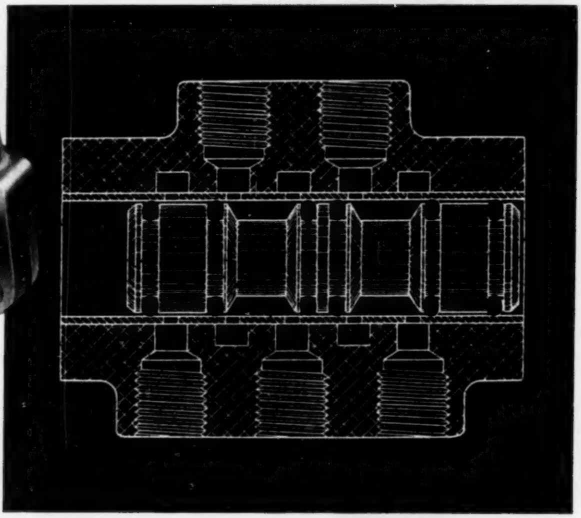




# TIP...

**FOR DESIGNERS**

## *Forty Million Cycles Without Wear Using...*

**LINEAR "O" RINGS**

Think of it! Forty million cycles—*eighty* million strokes—and still no sign of wear in a Modernair CV Series pilot valve using six Linear "O" Rings as a sliding seal between cylinder and piston.

This was no laboratory set-up. This example of outstanding service from Linear "O" Rings was reported by the Victor Equipment Company, users of Modernair control valves.

Trouble-free service measured in scores of millions of cycles is only one advantage credited to Linear "O" Rings. When wear finally does become evident, the valve is *completely renewed* simply by installing new Linear "O" Rings. Elimination of metal-to-metal contact makes possible the use of easily machined aluminum instead of cast iron or steel. This means low fabricating costs and light, compact construction.

Linear "O" Rings are compounded of natural or synthetic rubber, fluorethylene polymers, and "Silastics" . . . are molded in a complete range of J.I.C. and A.N. standard sizes, as well as hundreds of non-standard sizes and special shapes. Precision molded under rigid laboratory control, Linear "O" Rings may be depended upon for continuous and lasting service.

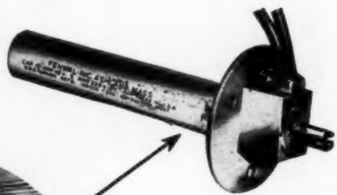
It will pay you to consult Linear during the design stages of your sealing applications.

"PERFECTLY ENGINEERED PACKINGS"

**LINEAR**

LINEAR, Inc., STATE ROAD & LEVICK STREET, PHILADELPHIA 35, PA.

# Uniform "proofing" for bakeries assured by Multi-Purpose THERMOSTAT

3 THERMOSWITCH thermostats control air in Anets Rack "Proof" Box. Thermostat (a) controls air temperature, thermostat (c) with wick acts as humidity control, and thermostat (b), set at 75 F, is wired in series with thermostat (c) to prevent moisture injection with resultant condensation and flooding when starting cold box.

Proper control of the "proof" box is a very important factor in commercial baking. These boxes "proof," or raise, yeast-type doughs by means of warm, humid air that is kept at a pre-determined temperature and humidity. This air must not only be held consistently to requirements, but must also be controlled in such a way that condensation is prevented when box is turned on.

To accomplish this, Anetsberger Brothers, makers of Anets proof boxes, chose Fenwal THERMOSWITCH thermostats. In successful operation on these boxes for more than ten years, these thermostats maintain conditioned air with laboratory accuracy. Operating on 24 volts A.C., they regulate temperature and humidity of air with such precision that bakeries can depend on uniform "proofing."

Low cost, compact, precise THERMOSWITCH thermostats solve many types of control problems. Easy to install, easy to maintain, they operate on a unique principle that permits effective control of many variables where heat is a factor. Their activating control element is the single-metal shell that expands or contracts instantaneously with temperature changes, making or breaking the totally enclosed electrical contacts.

Find out now how Fenwal THERMOSWITCH units can help you. Mail coupon today.

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SENSITIVE... but only to heat

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TEMPERATURE CONTROL ENGINEERS

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City ........ Zone ........ State ........

I am chiefly interested in the applications checked:

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☐ Alarm (over-temperature, under-temperature) ☐ Vapor Control
☐ Timing (thermal) ☐ Radiant Heat Control
☐ Pressure Control (by controlling vapor temperature)

OTHER (Please fill in your special requirements) ........
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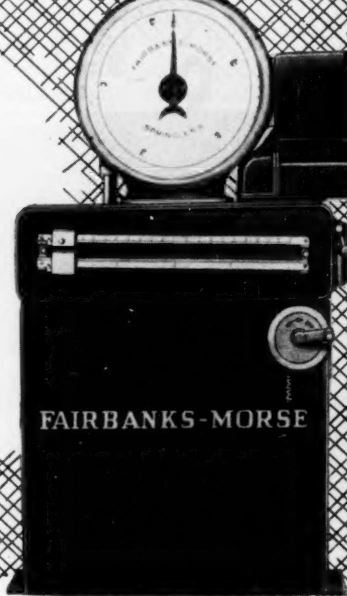
. . . then Fairbanks-Morse Printomatic Weighers are your answer. In addition to automatically recording weights on a ticket or tape, these weighing instruments can, through the use of electronics, automatically control production and processing operations. They can be adapted for automatic control of batching processes, materials handling, and conveying systems. They can open and close gates or valves, controlling flow of material to predetermined quantities. Templets can be used to preserve formula secrets when compounding mixes.

Fairbanks-Morse Printomatic Weighers speed operations. They eliminate the chance for human errors . . . eliminate inefficiencies and losses caused by inaccuracies. Your Fairbanks-Morse weighing expert will be happy to help you fit a Printomatic to your operations.

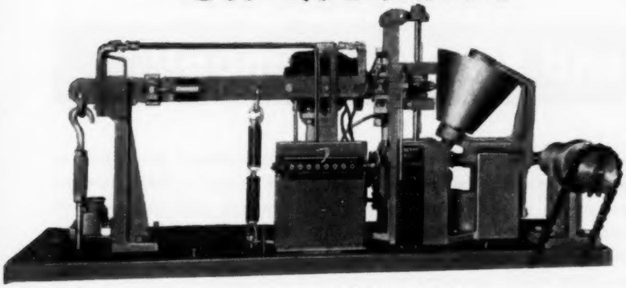



Printomatic Weigher

# -MORSE

## REMEMBERING

## WHEN YOU MUST WEIGH
# *"On the Move"*

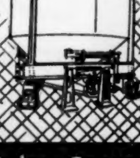


Belt Conveyor Scale

. . . check Fairbanks-Morse Belt Conveyor Scales. These efficient, accurate weighing instruments automatically weigh material in transit . . . provide cumulative totals up to 1500 tons per hour. Installed as an integral part of the conveyor system, Fairbanks-Morse Belt Conveyor Scales speed weighing of incoming raw bulk materials and materials in process.

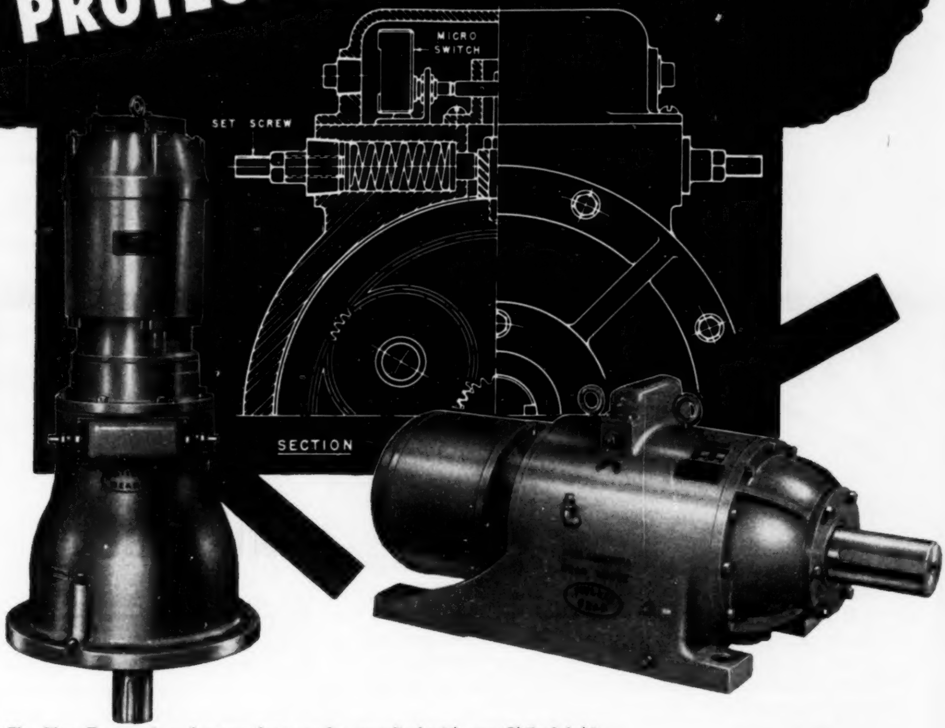
Whatever your weighing requirement, there is a Fairbanks-Morse lastingly accurate scale that exactly suits your needs. Fairbanks-Morse Scales or *component scale parts* can be supplied to fit right into your equipment for weight or control operations.

Hopper Scale



See next page for Fairbanks-Morse Sales Centers

# *Instant* PROTECTION Against overload




The PlaneTorque is a feature that can be supplied with any Philadelphia MotoReduceR *(combined motor and speed reducer)* or Philadelphia Planetary Reducer to protect both the driven machinery and the drive unit from dangerous overloads.

By direct mechanical action of the overload, motor current is *automatically and instantly cut off* when a pre-determined limit is reached. This action is quicker than electrical thermal relays provide. (With fuse protection only, fuses must be selected to carry the starting current of the motor; therefore, protection during running period is *not adequate*.)

The PlaneTorque can be cut-out during the starting period by merely holding down the starting button, but will become operative during running period when button is released. To re-start the PlaneTorque MotoReduceR after overload cut-off, *only removal of excessive load is necessary . . . a big time-saving feature.*

For applications such as stoker drives, conveyor drives, mixers, agitators, roll drives, etc. . . . investigate the PlaneTorque MotoReduceR.


**Send for Catalog MR-49, and please use your Business Letterhead when writing.**

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***Industrial Gears and Speed Reducers***
***LimiTorque Valve Controls***

# NEW — a low-cost* whiteprinter

## ANNOUNCING BRUNING'S MODEL 20 COPYFLEX

Here's the new Bruning Model 20 Copyflex. Because of its low price, thousands of companies now can make their own whiteprints and thus realize a substantial saving. Now you can produce your whiteprints *when* you want them—as you want them.

It will pay for itself by producing sharp, clean prints of your engineering drawings as well as copying your production orders, reports, specifications, defense order copies, etc.

The Model 20 is a completely new, medium volume machine of advanced design, yet sells for the lowest price of any machine in its class. It has a full 46" printing width, and takes cut or roll stock.

***Compare these advantages***

- ***LOWEST PRICED** machine of its class available.
- **NO FUMES.** Bruning Copyflex machines use no vapor developer, therefore cannot possibly emit unpleasant fumes.
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See how the Model 20 Copyflex, or one of our other models, can help you. There is a model for every price and volume requirement. Clip the coupon now and you'll be on the road to faster, less expensive copying.

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☐ Send me full details on the Model 20 Copyflex.

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# Why take it for

**We don't know the reason, but somehow chains seem to be taken for granted. If a chain for driving, timing or conveying has operated reasonably efficiently, that same chain is specified year after year. Yet, case after case shows that important savings can be made if these important functions are viewed with an eye for cost reduction and improved performance. For example:**

● A manufacturer had been using a standard roller chain for years on his machine. A Rex Field Sales Engineer showed him that he could use a Baldwin-Rex Double Pitch Roller Chain  and get the same operating efficiency at a substantial reduction in cost because speeds did not require standard roller chain.

● Another manufacturer had been using conventional flat top chain to carry cans through his machine. It was necessary to pay a premium for special bevel top plates to avoid tipping of cans. By switching to Rex TableTop®  he got even smoother tip-free operation at far lower cost.

● A business machine manufacturer, faced with the need for more accurate timing, consulted his Rex Field Sales Engineer and switched from leather belts to the smallest roller chain — $\frac{1}{4}$-inch pitch Baldwin-Rex No. 25  — and accomplished his objectives.

● In carrying material through a scalder, a manufacturer had been using conventional steel chain. By switching to Rex Cast Pintle Chain,  he not only cut his costs but the chain lasted far longer.

# granted?

● In another instance, a Rex Field Sales Engineer persuaded a manufacturer to switch from the pin-and-cotter roller chain he was using to a Baldwin-Rex Riveted Roller Chain.  The change not only resulted in an initial cost saving but in longer life since the rivets have greater holding power.

● To a manufacturer of construction machinery, who had been using cast manganese steel chains, a Rex Field Sales Engineer recommended the use of Rex Steel Chabelco Chains.  Since these chains are designed for efficient operation under dusty, dirty conditions, longer service life for both chains and sprockets at lower overall costs resulted.

**Chain Belt COMPANY**
**OF MILWAUKEE**

**Because Rex Field Sales Engineers have all the resources of a complete chain line at their command, they can recommend without prejudice the exact type or size of chain that will deliver the most efficient performance at the lowest cost to you and your customers. You'll find it will pay you to consult with him regarding your chain application problems. Call or write your Field Sales Office, or mail the coupon.**

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# MECHANICAL ENGINEERING

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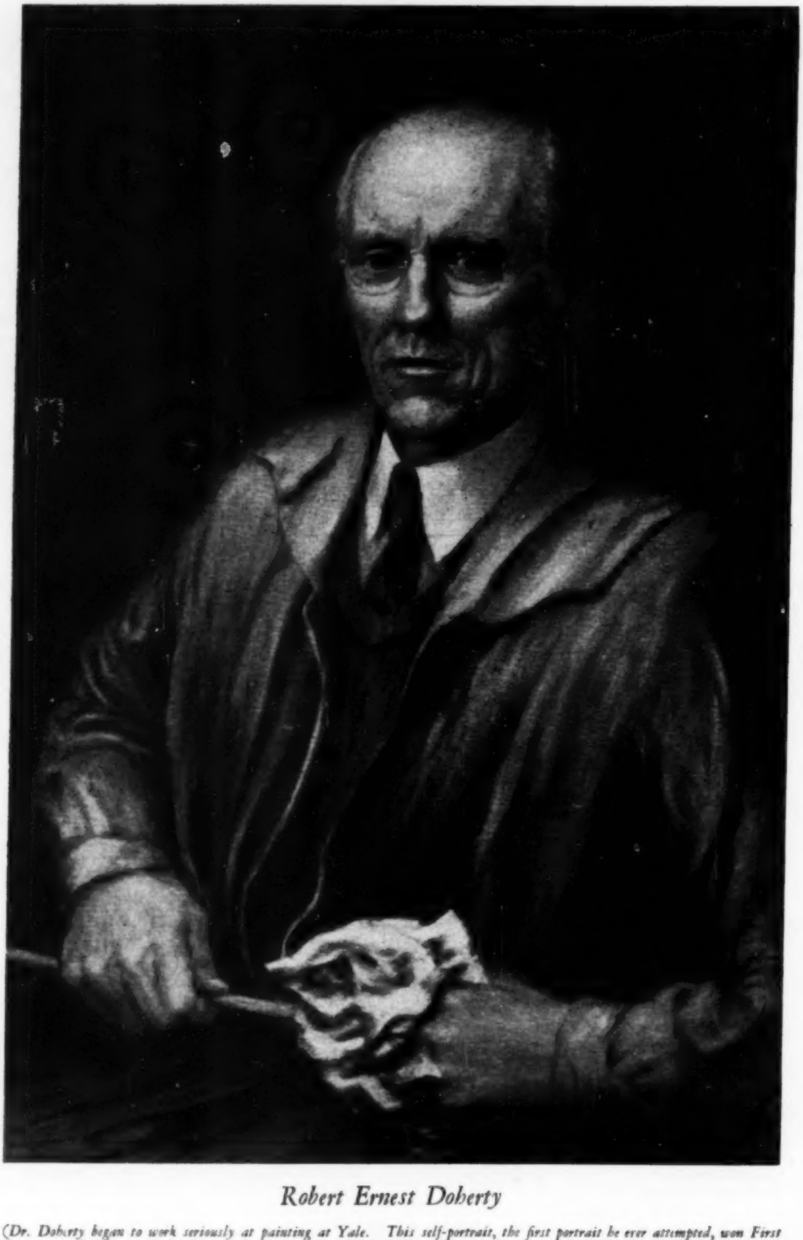

*Robert Ernest Doherty*

*(Dr. Doherty began to work seriously at painting at Yale. This self-portrait, the first portrait he ever attempted, won First Prize at an Exhibition of the Associated Artists of Pittsburgh. He used to tell his friends that the judges that year were women and "They wanted to give a prize to a good-looking man." Though he joked about it, the recognition pleased him. A sketch of Dr. Doherty's career by Edna Yost appears on pages 783–786.)*

VOLUME 73
No. 10

# MECHANICAL ENGINEERING

OCTOBER
1951

GEORGE A. STETSON, *Editor*

## *Harrison W. Craver*

Harrison W. Craver, consulting librarian of the Engineering Societies Library since 1945 and director for 29 years, one of the pioneer technology librarians of the country, died on July 27, 1951, in his seventy-sixth year. A graduate of Rose Polytechnic Institute with the degree of bachelor of science in chemistry in 1895, he was awarded the honorary degree of doctor of science by that institution in 1933 in recognition of his constructive and outstanding services as a technology librarian.

Dr. Craver began his career as a steel-plant chemist in an era when the public libraries of the country paid scant attention to technology. From 1900 to 1902 he served as technology librarian at the Carnegie Library of Pittsburgh where his pioneering work attracted the attention of other progressive libraries in large industrial communities and led to rapid expansion of this specialized form of public service. After a year spent as assistant superintendent of the Allegheny Iron and Steel Company, he returned to the Carnegie Library in his former post and, in 1908, became librarian. By this time his career as a librarian was firmly established. He threw himself with the zeal of an innovator into the problems of library administration and expansion of services to technologists and became a leader in his profession, as councillor (1909–1917), member of the Executive Board (since 1924), and president (1937–1938) of the American Library Association.

It will be remembered that a desire to combine the libraries of the so-called Founder Engineering Societies into a single, well-organized, and usable collection was one of the principal factors that led Andrew Carnegie to make his magnificent gift of the Engineering Societies Building in which not only the common library but the headquarters of the engineering societies would have a permanent home. It was to this library that Dr. Craver came as director in 1917.

Among the tasks of urgent importance was that of completing a catalog of the combined collections of books and bound periodicals so that the wealth of information they contained would be accessible to engineers. It was an era in which the literature of engineering was expanding rapidly and the use of libraries as sources of information was being developed by engineers. It was Dr. Craver's desire to make the Engineering Societies Library not only the largest and best of its kind, but to develop services which would increase its usefulness. To this end he instituted a number of innovations. Under his leadership the Service Bureau and the Photostat Service were established and a procedure was worked out whereby any member of the Founder Societies, no matter where his residence might be, could borrow books by mail at a nominal charge. The Service Bureau provided, in response to mail, phone, or personal request, references, abstracts, and translations of articles as subjects of interest to the searcher. The Photostat Service provided photostatic copies of articles or pages in any volume in the library and was later expanded, in co-operation with the nearby New York Public Library, to include bibliofilm copies. Dr. Craver also provided for the journals of the Founders Societies brief reviews of books received in the library. Because of the wide publicity given to these "book notes," publishers were willing to donate copies of the books reviewed to the library, thus enriching its collections and keeping it abreast with the times at minimum expense. In co-operation with Engineering Index Service Inc., housed on an adjacent floor of the building, he entered into an arrangement whereby engineering periodicals and books were made available for use by the Service, in exchange for which the Service maintained a complete file of the current index cards, as well as its annual volumes, in the library for daily use. For the Founder Societies he provided a permanent depository for their publications and also for manuscripts not published by them. These manuscripts were indexed and the cards became part of the general library catalog.

It was during Dr. Craver's administration that the Engineering Societies Monograph Series was established in co-operation with the McGraw-Hill Book Company. As chairman of the Monographs Committee consisting of two representatives of each of the Founder Societies, Dr. Craver reviewed book-length manuscripts on highly specialized technical subjects which a publisher would hesitate to accept without such substantial prestige as the Monographs Committee offered, because of a limited market, and, after further review by experts and approval of the Committee, arranged for publication by the McGraw-Hill Book Company. A list of distinguished textbooks and monographs has been the result of this far-sighted venture which had Dr. Craver's wholehearted support.

Today, when it is possible to find a number of large libraries devoted principally to technology, dozens of free public libraries in industrial centers with well-stocked and well-administered technology departments, and special libraries with competent staffs in research institutions and companies, it is easy to forget the services which pioneers like Harrison Craver rendered for the benefit of scientists and engineers and all manner of technical people. These pioneers recognized the opportunities and special needs of the technical library.

Theirs was the task of physical separation of the materials scattered throughout general collections, of developing techniques of making these materials easily available to researchers, of classifying and indexing the vast amount of information hidden in periodicals and books, of devising bibliographies, preparing translations and abstracts, and bringing to the attention of technical people the wares they had to offer. Their work lay at the foundations of research, and their knowledge of sources, subject matter, reference works, and techniques for discovering the grain of wheat in a bushel of chaff, saved the time of busy men and gave them a sense of assurance that nothing had been overlooked.

Harrison Craver was a quiet scholarly man with a profound knowledge of technological literature. Approach him on any subject and he could lay his hands on books by four or five of the leading authorities. He had an uncanny ability of remembering obscure references. He read German and French easily. He knew the latest books and could evaluate them from the points of view of authoritativeness and new features. One never turned away empty-handed after an appeal for help. He was equally at home with modern and ancient books. His comprehension of the history of technology and its significance was impressive. His conversation was cultured and sparkled with wit. As a table companion and raconteur he delighted his friends. One could trace his movements by the trail of brown-papered cigarette butts he left behind. For his friends he bridged the gap between technology and the other great cultures of modern society. A scientist by education, a librarian by profession, he knew and understood engineers and their work. He placed all engineers greatly in debt to him.

## To Command Recognition

UNDER the inelegant title, "A Helluva Shortage of Engineers," *Fortune* for September carries an informative article on that subject. It depicts the scramble for engineers that raged on the campuses last spring. It quotes some astounding salaries offered to young men just beginning their professional careers. It reviews the well-known figures of the engineering employment deficit, at present "well over 60,000," and the work of the Engineers Joint Council's Engineering Manpower Commission. It records as a "history of folly" the "wrong policies, wrong thinking, blunders, national obtuseness and indifference" which began in World War II with "indiscriminate draft policies" (still at work), to which some of the blame for the present emergency can be attributed. And, while paying tribute to the achievements of engineers, it raises the question, Is engineering a profession?

One can hope that the *Fortune* article will be read and comprehended by a large body of Americans who have it within their power to influence national thought and policy so that the great resources we have in engineering will be properly cultivated. If and when this happens and there results a widespread appreciation of the value of engineering and an economic and social climate favorable to rapid development of the engineering profession, the obligations placed by the public on engineers will demand a high quality of performance and leadership.

Fortunately, there is and always has been among engineers a conviction that public recognition of status and ability to discharge responsibility must be commanded by achievement and cannot be demanded as a right. American engineers have always been objectively critical of their standards, their problems, and their institutions. They have not waited for outsiders to criticize or point the way. They do not hesitate to discard old for new and better methods. As public consciousness of the nation's need for engineers increases, improved engineering curricula and higher standards of education must be developed, greater attention must be given by industry to recruitment and in-plant training of graduates, programs of higher quality must be offered by engineering societies, and a more unified organization of the engineering profession must be brought into being. Only thus can engineers command the public confidence in their competence and leadership that appears to be developing. If engineers fail, the free world fails.

## Preprints of Papers

THE American Society of Mechanical Engineers aims to conduct its meetings and publications for the benefit of its members. It has learned through experience that members are best served when preprints of papers are available for study in advance of a meeting. While it must give as many persons as possible the opportunity of contributing to the advance of mechanical engineering through presentation and publication of their papers, it must also maintain standards of quality and it must not waste members' time and money. Hence it must follow certain review and selection procedures when papers are submitted. When the time to carry out these procedures is added to that necessary to preprint and make available to members the papers selected, it is discovered that several months must normally elapse between the writing and the presentation of a paper. This time might be materially reduced if only one or a very few papers were involved, or if review procedures were lax or carried on by a small group of persons with nothing else to do. But such is not the case, and few members would, on reflection, desire greatly to reduce the number of papers, relax review procedures, or restrict the authority of review committees.

No matter how brilliant a speaker may be, a technical meeting is not wholly successful without an interested and well-informed audience. When authors are asked to prepare papers months in advance of a meeting date, the purpose is to assure a better meeting and a better audience. Time then permits thorough review of a paper by competent persons, the preparation of a preprint for advance study as a basis for discussion, a better reception of the paper, and a more widespread dissemination of the material it contains. Unless authors submit papers on time, there can be no preprint.

# ROBERT ERNEST DOHERTY

# (1885-1950)

By EDNA YOST

NEW YORK, N. Y.

WHEN the engineer who became president of Carnegie Institute of Technology in 1936 was graduated from college he had, he said, a "vague notion" about some of his inadequacies. Within him was a hazy realization that he did not completely understand the principles beneath some of the engineering practices and techniques he had learned. This vague notion about his inadequacies became a conviction during his early years in industry. Here he found he could not solve many of the problems a young engineer must deal with. Yet, often when a superior showed him the way out of his dilemma, Bob Doherty recognized that he already knew the principles upon which the solution had been based, but had somehow failed to recognize their bearing on the problem.

Contact with scores of other young engineers at General Electric, and later with hundreds of them, soon convinced him that he shared his inadequacies with graduates of every engineering school in the country. Everywhere student engineers had had their heads filled with facts and their hands trained to techniques. But they did not have the training which would enable them to think successfully through a new technical problem based upon the very principles they could quote so glibly from memory.

Because of what grew out of that conviction Robert Doherty's life has written one of the most important chapters in the history of modern professional education. There are still institutions able to call themselves engineering schools where the curriculum is more conducive to training technicians than to educating engineers. At Carnegie Tech, however, Robert Doherty set about creating an engineering curriculum in which an understanding of the principles beneath technological facts and routines is stressed, and in which ability to apply these principles to new problems is developed. But he went even further because it was his conviction that professional groups should furnish leadership in human and public affairs, and that engineers should be as responsible for supplying such citizen leadership as lawyers, doctors, or other professional groups. The curriculum he instituted at the Engineering School of Carnegie Institute of Technology thus combines fundamental education in engineering principles and the art of using them, with education which simultaneously attempts to develop a student's full human capacities and awaken him to his responsibilities as a potential leader in dealing with human, economic, and political problems. The young man or woman thinking of engineering as a lifework today thus has opportunity to secure educational preparation that develops his power to think out new problems in his profession, as a citizen and as an individual person.

### BOYHOOD IN ILLINOIS

Bob Doherty's boyhood was typical of that of thousands of other boys in the Middle West in the last decades of the nineteenth century. With his father, mother, and six brothers and sisters, he grew up in Clay City, Illinois, a rural community containing little stimulation to higher education. Its high school gave a boy a diploma without fitting him for entrance to the State University. Despite its impressive name, Clay City had only a few hundred inhabitants, and neither electric lights nor telegraph office when Bob was born. Maybe the fact that he was old enough to be impressed by the first electric lights in his community and to be excited by the arrival of its first telegraph office gave a dramatic importance to electricity which it would not have for later generations who never knew a world without such things. At any rate, by the time he was in high school Bob Doherty felt a greater pull toward the telegraph office in the B and O station than toward his father's drugstore. He knew instinctively he wanted to be an engineer and specialize in electricity.

By the time he had reached high school he was building his own successful telegraph instruments at home, as multitudes of boys of a later generation would be building radio sets. First his homemade instruments sent messages successfully from upstairs to downstairs in his own home. Then they communicated over a private wire he and a school friend set up between their homes with at least one house in between. The boys could understand the simple messages they signaled each other, but one of them was not satisfied to remain an amateur operator. Bob formed the habit of being in the station near train time, when telegraph messages had to be sent, so he could study the dots and dashes he heard. He made a regular practice of going down for the midnight train because the station-agent operator was not as busy then as at daytime train times. Often he got up in the middle of the night to go down for the train that passed through Clay City at 3 a.m. He made friends with the station agent and, in exchange for sweeping out the station and the performance of other chores, received instruction in the Morse code. It was this training which enabled him, after high-school graduation, to take a job with the B and O as a telegraph operator, salary forty-five dollars per month for a twelve-hour night shift.

A job in this period of his life was very necessary if Bob Doherty was to realize his ambition to become an engineer. Higher education was respected and encouraged in his home. His father had been a teacher before he became a druggist, and four of the seven young Dohertys would go to college eventually. But at this period of their lives family finances were limited more than they would become a little later. A year or more of preparatory education would have to be financed before Bob could enter the State University. He worked

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Initial chapter of a book, "Modern American Engineers," by Edna Yost, to be published by The J. B. Lippincott Company, New York, N. Y., in 1952. Miss Yost, who was at one time a member of the ASME Editorial Staff, will be remembered as author of the biography, "Frank and Lillian Gilbreth: Partners for Life," one of the ASME Biographical Series.—Editor.

All of the personal episodes in this sketch Miss Yost heard from Dr. Doherty himself in the course of a two and a half hour interview in New York City only three days before his death. Much of the material on the Carnegie Plan of Education was provided later by Carnegie Institute of Technology.

and saved what he could. But he was twenty-one years old before he was able to register as a freshman at the University of Illinois, aiming at a BS degree in electrical engineering.

### COLLEGE DAYS—AND CHARLES STEINMETZ

During that freshman year, and without any warning, one of the truly great events of Bob Doherty's life happened. Charles Steinmetz, electrical wizard from Schenectady, was scheduled to address the students on a subject of technical interest to future electrical engineers. Bob went to the lecture, he listened intently and, by his own admission, he did not understand a word the brilliant, physically misshapen gnome of a man said. Yet something from Charles Steinmetz communicated itself arcoss a sea of student heads that day in a way that marked the whole course of the younger man's life.

"Something about Steinmetz set me on fire," he said. "It was something that had never happened to me before. He set me on fire so truly that from the first moment of seeing and hearing him I was hell-bent on getting to Schenectady and to Steinmetz."

Came 1909 and his graduation and Doherty headed for General Electric's Schenectady plant to work. He spent his days in overalls, down in the dirt, often, looking under and all around a new piece of machinery that was not operating smoothly, trying to figure out what "the bugs" were which were hindering operation, and how to get them out. The very first Saturday afternoon he was in Schenectady he made inquiry and went out to see where Dr. Steinmetz lived.

"I wanted to look at the house," he said. "I was still so fired by him I just had to see the house he lived in."

The following Saturday afternoon he went again. This time he knocked at the door. "*I just had to see him.* Maybe it took a lot of brass but I had to do it. When he came to the door I told him I wanted to ask him some questions about problems I had met up with in my reading and study."

What Robert Doherty did not know that afternoon was that Dr. Steinmetz was glad to be approached by younger engineers who were genuinely interested in learning how to solve baffling problems by using their own intelligence. So the younger engineer was greatly relieved that day when the older engineer took the intrusion in a kindly manner and answered all the questions put to him. He was decidedly chagrined, however, when the older man, in turn, asked him some questions he could not answer. Still, he was encouraged enough to make the suggestion that had become too dominant within him that afternoon to be withheld.

"It would be wonderful for me if I could come out and talk with you every once in a while," he said as he was leaving.

"Fine. Come any time at all," Steinmetz replied. "If I'm busy, you can go home and come back another time."

Every Saturday afternoon for years Robert Doherty went back—every Saturday up until the time he had earned advancement to a position which gave him ready access to Dr. Steinmetz during work hours. At the end of those years Doherty could count on the fingers of his two hands the times Dr. Steinmetz had been too busy to see him.

The problems he took with him during those years, after that first Saturday when he had presented his own problems, always pertained to his work at General Electric. Soon many of them were pertaining to the design of synchronous motors and generators. After his year as a test engineer was over he had been assigned to the Company's engineering office as a design engineer, and gave much of his time to this line of work. Alternating-current machinery was then in an early period of its development and Doherty was baffled time and again with the problems it presented. Dr. Steinmetz would always point the way out of his difficulties.

"He did not tell me any new fact of book knowledge," Doherty said. "He merely pointed out a principle of physics which, if applied to the problem at hand, would tell me what I wanted to know. Then he applied it, and he always made full use of mathematics. Now I already knew the principle. I could recite it. By this time I sometimes even understood it. What I did not understand was that it would help me solve this specific problem. The simple fact is, I had not learned to analyze the situation in terms of general principles.

Finally Bob Doherty began to be ashamed to "face the music," as he called those sessions in which Dr. Steinmetz pointed out to him a principle he already knew but had not learned to use. A curious thing happened then.

"When I got stuck I began to ask myself how Dr. Steinmetz would look at the problem. Gradually I began to stand on my own mental feet. Repeated exposure to the discipline of Steinmetz' mind taught me, within my own mind's limits, how to think about a problem."

Meanwhile the great Schenectady wizard had begun to pass some of his problems along to Doherty. "I gobbled that up," he said. Soon I was spending so much time on Dr. Steinmetz' problems that I suggested going into his office instead of remaining in the office to which I had been assigned."

Steinmetz agreed heartily with the suggestion, as did G.E. officials. So, in 1918, after nine years of increasingly frequent contact with each other, Mr. Doherty was appointed assistant to Dr. Steinmetz, a post which kept him in the closest daily contact with this great genius until the older man's failing health, and finally death, severed their relationship in 1923. By that time, and continuing until 1931, Mr. Doherty was in a full time consulting engineer's position with the Company, as Dr. Steinmetz had been, working in his old chief's office, which meant a lot to him.

In the period of his association with Dr. Steinmetz and later, Mr. Doherty published some important technical papers. They dealt with synchronous motors and other synchronous apparatus, exciter instability, and other phases of work which was rapidly bringing our high-tension electrical systems to the adequacy with which the world is now familiar. They described work which was not only producing practical results in increasing the adequacy of electrical transmission, but which had extended the whole theory of alternating-current machinery. Recognition for his work was accorded him, and recognition usually stimulates a man like Doherty to further effort in the line in which recognition is being won. But in this period of recognized achievement in engineering Mr. Doherty had been experiencing a type of helpful relationship with other human beings which carried him as inevitably toward a professor's chair as he had originally been urged toward Dr. Steinmetz and General Electric.

### THE URGE TOWARD TEACHING

The impetus to a new field of work came primarily through contact with thousands of graduates from more than one hundred engineering schools. These young men had been bringing their problems to his desk year after year as he had once taken his problems to Steinmetz. It was in this period, as was said earlier, that he realized that not just a few schools were failing to train students "to analyze problems under their own steam" and think them through scientifically in terms of principle, but that all engineering schools were failing. Yet this was the kind of educational process all young professional engineers needed if they were to be prepared properly for the work they would be called upon to do. It seemed undeniable to Mr. Doherty that student engineers ought to find in their engineering colleges this type of education, and the challenge to create such a curriculum became dominant within him.

In short, Robert Doherty was on fire again and the flame now led him away from industry toward college teaching. Because of his interest in teaching, he took out-of-hours courses at Union College to deepen his theoretical knowledge and earned a Master of Science degree in 1921.

Teaching opportunities soon came, for engineering colleges were on the lookout for engineer-teachers who had had experience in industry. But Dr. Steinmetz said "No" and General Electric officials said "No" to every suggestion Mr. Doherty made about leaving. They all assured him he would make a mistake if he left industry for college teaching. Doherty turned down several offers but insisted that nevertheless he was going to do for young engineers what could not be done except through teaching. Knowing he would do what he said he would do, the officers at General Electric finally said, "Very well. If you *must* teach, do it here," and permitted him to set up a three-year program called "The Advanced Course in Engineering" which was given one full morning a week to a selected group of General Electric's engineers.

The first year—1922—twenty-four men were selected from about 500 engineers, and Doherty began the development of a course designed to teach engineers how to think scientifically and creatively about any problem met in their daily work—and with plenty of mathematics, as Steinmetz had always insisted. As Doherty himself had once learned this way of thinking, he now tried to teach young men to analyze the facts of a baffling problem so that they might recognize the principle upon which solution of the problem depended and then to discover a basis for solving it. Every Saturday morning they came, bringing their problems with them. Doherty knew that if this carefully selected group learned the proper way to approach and think through a few problems they could apply the method successfully to all problems.

### NEW RESPONSIBILITIES AT SCHENECTADY

At the end of the first year ten of the twenty-four were selected to continue for the next two years of the course, and a new group, this time of thirty-five, selected to enroll for the first year's work. Soon the results were what might be expected from a man like Doherty when he was on fire with an idea, especially in the realm of teaching in which he was truly superb. In scores of young men, talents were developed which the company recognized as far too valuable to be wasted on jobs where they did not have scope. Mr. Doherty's job became more and more a personnel job. He discovered the young men of exceptional talent through his teaching, and then not only had to find the right spot for their special talents but, as he described it, "pick up the apples" from all the apple carts knocked over in those spots. For personal problems often arise when a man of superior technical talents is assigned to some knotty old problem and institutes new methods in order to untie the knots. True, Mr. Doherty retained interest in some of his own researches, but eventually he found himself spending much time acting as assistant to the vice-president in charge of all personnel problems.

Then 1930 arrived, and already the depression was taking serious toll in Schenectady in engineers dismissed. A desk handling personnel problems is never a creative spot in times like this and Mr. Doherty's job lacked satisfactions it had once held for him. So when Yale University, which had had an eye on his educational course from its inception, offered him a professorship in electrical engineering, he accepted it.

To leave a good job promising advancement in industry for one in the lower-salaried educational world seemed a great mistake to many people. Measured by the standards Robert Doherty himself cherished, university teaching offered more than industry and he was happy to be making the change.

Yet he found himself very unhappy about leaving Dr. Steinmetz' office which he had kept as it was when his old friend had left it. The man who had taught him how to think, the man who had given him an enduring enthusiasm for learning held a place in his heart that was very real. So he suggested, and General Electric agreed, that the old desk and blackboard should go to Yale with him. The gift was made to the University and it was a matter of genuine regret to Dr. Doherty later that he had to be separated from that beloved old desk and blackboard when he went to Carnegie Tech.

### PROFESSOR AND DEAN AT YALE

At the Engineering School at Yale, where he became dean in another year, Doherty started out to develop the sort of analytical education that Steinmetz had given him. In addition, he immediately attacked one phase of what may well be one of the most important problems in America today—the problem of creating an educational system that develops whole men and women. This was something that went beyond what he had caught from Steinmetz. Doherty had long been living a full human life. A good citizen in his community of Scotia, outside Schenectady, he had served for one period as its mayor and for a longer period on its school board. A warmly human man at home, he was helping inculcate in his children high moral, aesthetic, and spiritual ideals as he and Mrs. Doherty guided their development. His own marked gift in art was developed through his interest in developing the gifts of his artist daughter. In his professional life he had contributed to technological advancement without diminution of his understanding and handling of the human problems in engineering. Now he would attempt to create at Yale a spot in the educational world in which engineering students would learn how to think for themselves in their engineering education and, in addition, in ways which could be carried over to problems in any human realm—history, economics, public-school education, or community relationships.

To accomplish both these things takes time. To get time for both, it was necessary for students to learn fewer engineering facts and to focus more deeply on a more limited number of engineering subjects than was customary in engineering curricula. He therefore had to convince authorities at Yale to drop courses in a time when increasing knowledge meant that there were more and more information and technique to teach. With his inner fire, Mr. Doherty was very convincing. Faculty members from other branches of learning in the University agreed to co-operate by giving guidance to Doherty's students. But he was appalled, when he tried to have his first students in engineering apply scientific methods outside their own specialty, to find they had little desire to think at all about anything but engineering! Finally a few students agreed to work in a subject outside their own field but only one of them, that first year, carried the project through for credit toward a degree.

Because educational projects aim to develop people rather than to change things, they are slow to bear fruit. But each year the fruits showed a little more clearly the validity of Doherty's ideas. At the end of his five years at Yale two unique courses were established in the electrical-engineering curriculum. The first was a course which employed the same methods of causing students to think through problems under their own steam which had made the advanced course at the General Electric Company so successful in developing creative analytical power. The second, far from pertaining to electricity, was taught by a man loaned to the Engineering School faculty, who was a PhD in history! Some students, at least, were accepting the idea that, since their professional life would not be lived in a vacuum, their education should take account of the environment in which their profession would be prac-

ticed. Still the difficulties of changing engineering education fundamentally in a great university where many of the professors who taught courses in the engineering curriculum were not on the engineering faculty were baffling.

### TO CARNEGIE TECH AS PRESIDENT

In 1936, at the age of fifty-one, the great opportunity arrived for which the whole of Dr. Doherty's experience had been fitting him. He was elected president of Carnegie Institute of Technology in Pittsburgh. Here he was in complete charge of all aspects of engineering education. He thus had an opportunity he had not had before of guiding the whole educational process toward the fulfillment of his vision. Gradually he built up a faculty interested in joining with him in making this vision a reality.

As the faculty grew stronger and worked longer together, they took more active part in the planning as well as the teaching until it became difficult to tell what part of the plans came from Mr. Doherty and what from those associated with him. But he was the originator, inspirer, and leader of it all. It was he who got the faculty members in different fields to pull together—engineers with historians, English teachers with mathematicians. Gradually the vision became clearer and fuller, and as it did so became known as the "Carnegie Plan."

The essence of this plan is its emphasis upon one thing—developing in students the character and ability that will enable them to think self-reliantly and well throughout their lives and on all aspects of their problems and their responsibilities. This Mr. Doherty had made the core of the matter at the very start. "The crucial question," he said, "is: on which of the two—thinking or subject matter and techniques—is the primary emphasis to be laid?" and he answered this question unequivocally, "It should be on the thinking process."

This is still the core of the Carnegie Plan. Under this plan good engineering education is conceived of as equipping students to be resourceful, able thinkers—thinkers who can use fundamental knowledge to learn new things and to solve new problems by themselves, and who can deal with the human and social as well as the technical problems of their work.

If students in college are taught how to think so they can learn for themselves and are given the root knowledge they need to learn with, they will be able to go on learning from study and from their experience after college. If students are taught fundamental principles and also taught how to analyze problems by using these principles, they can find their own way through the constantly changing perplexities of modern work and modern life.

If they are also taught to think and learn and solve problems in regard to human, social, and engineering questions, they will have two great advantages over men who are taught to think narrowly. On the one hand, they will be able to handle all sides of their professional problems—the human, the economic, the social, and the spiritual, as well as the technical—for engineering problems like all professional problems have all these sides, and the man who can handle only the technical side will always be dependent on someone else who is able to see the full horizon. On the other hand, students so taught will be able to use their professional ability in the problems that come to them as persons and as citizens as well as workers.

Hence Carnegie built up a program which met squarely the problem of how to prepare students to handle all sides of their problems and to live as responsible citizens in a free society. This program consisted of courses in social relations which are a harmonious part of engineering education.

The essence of the teaching under the Carnegie Plan is to get the students to do their own thinking and do it well. So Carnegie Plan students do in their courses, with the teacher as a coach but with the student as a thinker making his own decisions, the sort of thinking that they must do later in life if they are to learn and grow and handle problems well. In doing this, they learn the root knowledge that they later need. In no other way can they learn so thoroughly and so lastingly and make what they learn so useful.

Each year students and faculty grew in understanding of the aims of the Carnegie Plan and what it might achieve. In the Engineering School increasing numbers of students began to find new enjoyments in reading literature and history, and in understanding human and social problems. Even more, they began to find the pleasure and value in study that enabled them to stand on their own feet with self-reliance, no matter how broad or how new the problem which they faced.

Doherty lived as a whole man and a responsible thinker. He attempted to find better ways to develop students in their capacities to live as whole and eventually mature citizens. To know how to think, to want and to make the effort to think and think deeply, broadly, and with disciplined order, was fundamental to the way Doherty lived, and to the way he wanted students to learn to live. "I urge you to take the initiative and learn to use your heads," he said to them. "Dig yourself out of confusion. Insist on understanding! Stop memorizing words and formulas that you don't understand, merely for a grade. Don't go on cultivating a habit that will cripple your mind for the rest of your days—the habit of superficiality, the habit of accepting confusion as a normal state of mind. You know when you understand and when you don't. With all the emphasis in me I repeat: insist on thoroughness of understanding!"

### RETIREMENT AND THE NEXT STEP

He worked with his tremendous energy and fire, and at his retirement age he had lost no whit of his enthusiasm for education and his personal need for continuing to learn. Actually, he was glad to retire at sixty-five. A man like Doherty always has confidence in humanity, so he knew others could and would carry on the work he was leaving. As for himself, he was eager again for the next step. He intended to think through some problems about painting. How far could his techniques for thinking be applied in the field of art?

He had brought his ideals to reality through the belief that *if a person knows what he wants to do, and then relates every act and effort of his life toward the dominant thought in his mind*, success in achieving his desire is bound to come. "If only I can help you fully to understand that," he told his artist daughter, "I will have fulfilled my function as a father."

He had wanted to be an engineer, and then to help young engineers become better engineers, and better engineers to become better human beings. He had uncovered and developed latent capacities in himself all along the way. There was still something he wanted to do and, though it lay in the realm of art, it was a development out of, not a deviation away from, the dominant desire within him—the desire to learn how to meet new problems and think them through on the basis of eternal principles which are discoverable.

So he built his new home in Florida with a studio in one half of the garage and a window just as he wanted it. He was ready and eager for the next step when his physical life suddenly ceased. Already a generation of engineers and teachers who had lived within the sphere of his direct influence were carrying his ideal in their lives and adding to it their own creative contributions. For that was Robert Doherty's effect upon people. In the highest sense of the word, he was an educator. His inner fire kindled the creative instincts of his fellow men.

# TURBOJET TRANSPORTS

## *With Special Reference to the Comet*

By W. G. TOWNLEY

GENERAL MANAGER OF OPERATIONS, CANADIAN PACIFIC AIR LINES LTD., VANCOUVER, AMF, B. C., CANADA

THE commercial operation of turbine-powered aircraft has aroused intense interest among the world's airline operators and within the engineering fraternity. This paper outlines in general terms some of the main operational problems which confront an airline operator on a specific route and provides some of the background around which the decision to operate a turbojet transport was based.

### THE ROUTE

One of the first decisions which an airline management must face in evaluating a new aircraft is—where will we use it? Canadian Pacific intends to operate the de Havilland Comet initially on its North Pacific route, originating in Vancouver, British Columbia, and terminating at Tokyo. Although this route continues beyond Tokyo to Hong Kong, it will not be possible to operate the Comet beyond Tokyo until certain improvements to the present restricted airport at Hong Kong are made.

The choice of a route is based mainly on two factors: (1) the need for service which exists as a result of traffic commitments, and therefore the amount of revenue which is available to the carrier, and (2) the operational characteristics of the route which determine the type of equipment which can be operated over the route.

From an economic point of view, it is necessary to apply the Comet to routes where the various terminals to be served fall within the classification of a long-range operation. This economic requirement is based on the fact that the optimum cruising altitude of a turbojet-powered aircraft is so high that it becomes impractical to consider the operation of such an aircraft between any two points whose distance is separated by less than 1200 nautical miles. The Orient route was chosen operationally, bearing in mind these distance requirements, the generally lower ambient-air temperatures which apply, and the adequate runway lengths and navigational facilities at the points of call.

### THE AIRCRAFT

A three-view drawing of the de Havilland Comet is shown in Fig. 1. It is comparable in size and capacity to a Douglas DC-4. It is not necessary for the Comet to incorporate many of the space-consuming and weighty passenger-service facilities which are required in current transports, primarily because the speed of the Comet is almost double that of current transports. This aircraft therefore reaches its destination in half the time, and the necessity for providing meals, refreshments, and other services is consequently reduced. This is not only a substantial initial cost saving but a continuing operational saving. A proposed interior layout of the Comet is shown in Fig. 2.

One of the major problems which confront the operator of

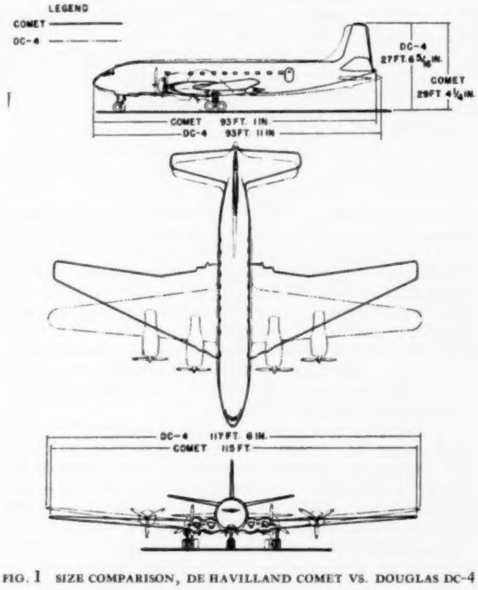


FIG. 1 SIZE COMPARISON, DE HAVILLAND COMET VS. DOUGLAS DC-4

present-day piston-engined propeller-driven transports is the necessity for complex electronic and other automatic controls which are not only weighty and expensive, but also require the expenditure of a large number of maintenance man-hours and contribute very often to delays, all of which represent a substantial expense to the operator. Because of the basic simplicity of the centrifugal turbojet engine, automatic engine controls are not necessary and have not been embodied in the Comet. One of the features which most impresses the airline operator is this simplicity and the fact that it has been possible to eliminate the compounding of gadget upon gadget to produce unnecessary mental hazards and expense.

The Comet, as ordered by Canadian Pacific, has a maximum allowable gross weight of 110,000 lb. It is powered by four de Havilland Ghost centrifugal-flow turbojet engines, each engine capable of 5500 lb of static thrust.

### METEOROLOGY AND WEATHER

The main meteorological problem in the application of a turbojet transport can be generally resolved into the procurement of more data to provide more frequent and accurate forecasts.

For operating efficiency, the Comet must fly at a cruising altitude of approximately 40,000 ft which is almost double

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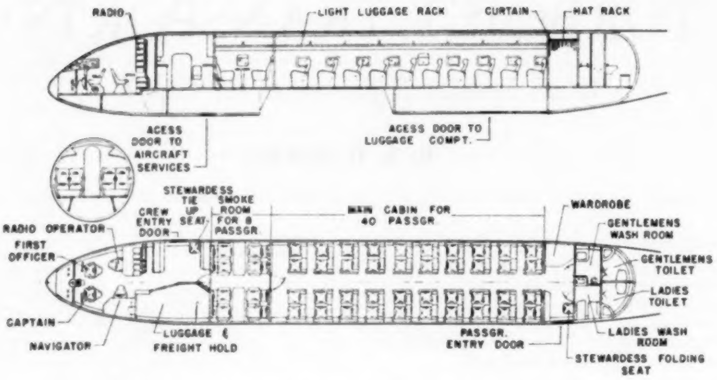


FIG. 2 COMET INTERIOR LAYOUT, CANADIAN PACIFIC AIR LINES

the cruising altitude of the average current propeller-driven transport airplane. The variation of wind and temperature at the Comet operating altitude is not available for all areas of the world. To provide data on which to base forecasts will require additional weather stations and more upper-air observations. These stations, either land-based or seagoing, are expensive to construct and operate. The member States of the International Civil Aviation Organization are putting forth every effort to add to these stations and Canada now has a weather ship *Peter* stationed in the Pacific Ocean at latitude 50° north and longitude 145° west.

It is desirable, for airline purposes, that forecast data be accurate within plus or minus 10 to 15 knots for track and beam wind components, and plus or minus 10 C for temperature. This degree of accuracy may not be met with the present-day instrumentation and facilities, and it is undoubtedly true that development costs for improved equipment will be high.

The possibility of turbulence or sharp gusts at 30,000 ft and higher is almost certain, especially in the tropic or middle latitudes. Here the North Pacific route will give the answers to such problems in easy stages. Military jet experience indicates that these gusts are not as severe or frequent as is sometimes forecast from theory. This same experience has shown that the swept wing embodied in the Comet effectively alleviates much of the gust effect. This effect is not passed on to the passengers unless the gust is of long duration, in which case it would not then have a sharp gradient. The likelihood is that gusts encountered at altitudes lower than 20,000 ft may cause more passenger discomfort and will probably require a reduction of speed. However, this would apply only during approach or standoff at which time such speed reduction is normal.

The problem of thunderstorms, rain, or hail should not occur normally in the mid or northern latitudes at the Comet operating altitudes. However, during the climb and descent, these conditions will require attention and possibly a change in flight plan. A solution to this would appear to be available through the use of forward scanning radar. Such equipment is being investigated and it is likely that British equipment now available will be satisfactory.

The problems associated with the deicing of the centrifugal-flow turbojet engine are insignificant.

Airframe deicing on the Comet is achieved thermally through the provision of heat to the leading edges of main-plane and tail-plane surfaces. Thermal deicing is necessary since the use of pneumatic boots is not practical in high-speed flight for aerodynamic reasons. The Comet obtains the heat required for airframe deicing through the bleeding of hot air from the engine compressors. This is another instance of simplification as opposed to the necessity for the provision of a separate heat source for deicing in current thermally deiced transports.

The difficulties of icing appear to be no more severe with the Comet than with present aircraft.

### AIR TRAFFIC CONTROL AND NAVIGATION

Air traffic control can be divided into several divisions, the first being "let-down" to the airport. Two possible solutions are offered: (1) that the let-down start from the cruising altitude at 30 to 50 miles from the destination, giving a sharp rapid rate of descent of 4000 fpm; (2) that the let-down should start from the cruising altitude at, say, 300 miles from the destination with a prolonged rate of descent of 500 to 700 fpm. Neither method shows a marked difference in the air-mile per pound figure, although the block-to-block speed will differ slightly. The second method, which Canadian Pacific favors, makes use of a constant indicated air speed of 220 knots during the descent from the cruising altitude. However, some operators are inclined to the more vertical descent, since it does not cut through as many en-route altitudes or require as large a traffic cylinder at the holding point. Associated problems include the heat reduction from the compressor bleed-off for thermal deicing and cabin heating, since the engines are throttled for descent. The engine power available for accessory drives is also reduced for the same reason and it may be necessary to consider accessories driven by a separate power supply.

The problem of holding or stacking will be most serious at points of heavy traffic. The stacking of assorted piston and turbine-powered aircraft should not cause any acute problem, except at the end of long flights, because the turbine-powered aircraft can be given a prior landing clearance should fuel run low. This is now a normal air traffic control procedure.

It may also be possible to reduce the stacking problem connected with turbine-powered aircraft because the percentage of estimated time of arrival (ETA) made good will be higher and a direct approach to the runway is conceivable for the majority of cases.

The main navigational problem is the reduction of the time required to obtain a position. Considerable progress has been made toward this end, and present techniques represent a great advance from those of two years ago. Any further improvement is mainly dependent on the development of instruments for recording data and performing calculations automatically.

Pressure navigation will be limited to the single-drift technique for the following reasons: (1) sufficient upper-air data are not available for the construction of reliable forecast charts at flight level, and (2) the greater an aircraft's speed, the less the gain to be derived from following any track other than the Great Circle.

The navigational instruments will include the periscopic sextant, the air position indicator (API), the radio altimeter, loran, and possibly distance measuring equipment (DME) and omni-range equipment (ORE).

Since the navigational aids will be predominantly electronic in characteristic, the problems connected with the suppressed antenna will remain until operational experience has been gained. The greatest antenna design problems to be overcome are structural and electrical—the former because of possible structural discontinuities, the latter for perfect bonding and proper location for maximum reception.

These antenna problems also apply to the communications equipment, with the expected increase in precipitation static due to increased speed. Fortunately, due to the dryness of the atmosphere at 40,000 ft, this problem should be effectively reduced for the cruising condition. However, the greater portion of all communications takes place during the climb and descent—therefore this problem may remain.

Additional power for radio transmission at high altitudes may not be necessary according to available data.

### PERFORMANCE

The take-off and climb characteristics of the Comet meet the current International Civil Aviation Organization (ICAO) standards. Runway gradient and wind direction will have their normal effect. The effect of humidity is still being investigated and the final determination may require an operating penalty. The most severe penalty will be imposed by temperatures above International Commission for Air Navigation (ICAN) standard (15 C). The temperature and humidity penalties may be overcome to a large extent by water or water-methanol injection, or by the use of rocket-assisted take-off. From the foregoing it is felt that, for the route under discussion, the Comet problems will be minor since all the airports are near sea level and in relatively temperate climates.

The temperature penalty can also be overcome by proper scheduling of departures. At an airport with a normal high ambient-air temperature the departure should take place during the cooler part of the day, either morning or evening.

The landing problems of a turbine-powered aircraft should be no greater than those presently experienced, provided that adequate braking is available. The Comet has a landing speed of 75 knots, which is partly realized by the large flap area. Adequate braking is available through the use of the bogey undercarriage, which provides increased braking surface by having one brake for each of the eight wheels. Skidding may be overcome by the use of one of the antiskid devices now being developed. It is anticipated that brake maintenance may increase since reverse thrust will not be available—which will be a sizable maintenance problem. A balked landing should not present any problem since the landing-climb performance is superior to contemporary piston-powered transports, due to a large power reserve.

Commercial airline operators are most concerned about the required operational allowances. These allowances consist of extra fuel to take care of unpredicted winds, navigational error, engine maladjustment, holding, etc. It is our opinion that there will be as many solutions to the problem as there are operators, which is the case today with piston-powered propeller-driven transports.

Several points worthy of consideration are the following:

There is a penalty involved with full-throttle operation of the Comet below the 30,000-ft cruising level. This penalty amounts to an increase in the specific fuel consumption of $7^1/_2$ per cent for each 5000 ft below that level. For a 1000-ft decrease in altitude below the stated level, there is a 14 per cent decrease in air-miles per pound. Add to these figures the increase in fuel consumption for a possible icing condition, and it is very clear that precise en-route control is an absolute necessity.

Some manufacturers state that for the three and two-engine operation the air-miles per pound does not change appreciably for a given altitude and weight. However, the cruising altitude must be lowered and the possibility of encountering unfavorable conditions is therefore increased under those operating conditions.

### CREW REQUIREMENTS

Special piloting skills are not necessary for jet aircraft; also age, experience, and psychology should not differ from present standards. Present crews, with proper training, can safely carry through the operation. Their operating technique and experience will be aided by more accurate data presented in a form easy to assimilate and interpret.

### AIRFRAME AND ENGINE OPERATION AND MAINTENANCE

Opinion within the industry indicates that airframe maintenance will not pose any additional problems to those encountered on DC-4 aircraft. If anything, the airframe maintenance work, and accordingly, costs, should be reduced. Known military experience indicates that instruments and accessories have a 30 per cent increase in operating hours.

Thus far, military jet experience indicates that no problem will arise, due to extremes of operational temperature, between —70 F and 100 F.

The operation of a turbine power plant will require the close attention of the pilots and a cognizance of the operating variables. In other respects the operating problems should not present any particular difficulty. A good deal is heard about combustion-chamber "blowout" where the flame is snuffed out at high altitudes. This did occur in early engine designs but the possibility has been largely eliminated in the Ghost engines installed in the Comet. Should a blowout occur, the engine can be restarted by descending to an altitude of 20,000 to 25,000 ft. In so doing, the aircraft will accelerate and thereby rotate the idle engine to the approximate starting rpm. By pressing the ignition switch the engine will start immediately. If an engine is left idle for an extended period of time it should not freeze due to congealed oil since it will be rotating always.

The cost of commercial turbine-engine maintenance at this time can be only an estimate. A 2 per cent loss in power during the period between overhauls accompanied by a 2 per cent increase in fuel consumption is anticipated. The power variation between production engines may be about 4 per cent.

### GROUND OPERATION

There are few problems connected with the ground operation of turbine-powered aircraft which will be new, and none which are insurmountable.

Due to the large starting inertia of the turbine engine, the existing electrical ground-power unit of 300 amp will be overloaded. It is necessary to have available sufficient power to meet a starting surge load of 600 amp. It is hoped to rework present equipment by adding a heavy battery "float" in the lines to carry this surge. Once one engine is operating, sufficient power will be generated to start the remaining engines. de Havilland advises that the Ghost engines have been started

successfully on the aircraft batteries, which should enable operation from alternate airports without the use of a ground power supply. On the ramp, the air intakes or jet pipes will offer no more hazards for the ground crew than present propeller aircraft since these openings are six to seven feet above ground level. For engine testing, the aircraft will be in a protected area with guards installed to minimize potential personnel hazards.

Noise elimination will be the greatest problem during ground testing, and to date not any of the systems now in use have been decided upon.

Refueling the Comet will pose some problems mainly because of the large quantity involved, i.e., 7050 imp gal (57,105 lb). The largest tender at Vancouver Airport, for example, carries 2660 imp gal. For en-route points refueling stopover periods are long enough to eliminate any delay due to refueling. Domestic operators with only a matter of minutes for a turnaround will require either tenders of larger capacity or more units of the existing type. Additional units will be required for refueling as long as piston and turbine-powered aircraft operate from the same point, since the different fuels cannot be mixed. The Comet has underwing refueling rated at 200 imp gpm, which will speed up the operation, especially if a fuel hydrant is installed at the ramp.

The kerosene type of jet fuel has a deleterious effect on blacktop (macadam) ramps, taxi strips, and runways, since it softens the surface. The ramp, taxi strips, and the first 200 ft of the runway, exclusive of the run-up positions, should be concrete, and even then the expansion-joint compound will require additional maintenance. At the areas mentioned a large amount of fuel drains from the engine during starting and take-off which is not likely to be eliminated.

### FUEL AND FUEL SYSTEMS

Nearly everyone understands that turbines will burn a cheaper grade of fuel, namely kerosene. Unfortunately, kerosene is not plentiful since the oil refineries are forced to concentrate on the production of 100–140-octane gasoline which is in greatest demand. It is believed that when kerosene requirements closely approach those of high-octane fuels, the price will tend to do likewise.

There are now as many specifications for jet fuel as there are types of jet aircraft. The British staunchly support pure kerosene, the Americans specify a "souped up" kerosene obtained by adding quantities of the more highly volatile petroleum fractions, while the Canadian specification lies between the two extremes. The British specification retains the safety of the kerosene high flash point and the low vapor pressure, but has a high freezing point of —40 F. The American specification loses to some extent the safety fuel feature, but lowers the freezing point to —58 F, which is important considering the low ambient operating temperatures. De Havilland offset this point by stating that the mass of the fuel is so great and the flight time so short that the fuel never reaches the lowest ambient temperature so far encountered, —67 F. The addition of the more volatile fractions increases the vapor pressure which, if the trend continues, will require pressurization of the fuel tanks.

### PASSENGER COMFORT AND SAFETY

The greatest criticism of proposed high-altitude operations has been connected with the possibility of explosive decompression. This should not be a problem of consequence if the original design philosophy has been properly applied. De-Havilland has taken the position that the window installation, for example, should be relatively as strong as the wing spar in that neither should fail under any foreseeable operating condition. One does not worry about the wing collapsing—one should therefore have no worries about the windows blowing out.

By using this basic philosophy, the amount of oxygen to be carried can be held to a minimum. The crew stations will be equipped with a "demand" system of 1800 liters utilizing full face masks. The passengers will be protected by several portable bottles of 200 liters each, for therapeutic purposes only.

The atmosphere at 40,000 ft is very dry and the cabin humidity will be too low unless moisture is added. The Comet has a humidifying system whereby water is sprayed into the air during the recirculation cycle. Ten gallons of water have been proposed initially by de Havilland for humidifying purposes which should be adequate for a six-hour flight. However, operating experience may necessitate additional tankage. Refrigeration may be necessary in some latitudes but only to an altitude of 20,000 ft.

The cabin noise-level distribution in turbine-powered aircraft is the reverse of that experienced with piston-powered aircraft, it being of low intensity in the cockpit and increasing in intensity toward the tail. The noise consists of a continuous-sound-frequency spectrum generated by the rotating engine components (compressor and turbine), combustion chamber, and jet gas exhaust.

The compressor noise is generally unidirectional, extending forward from the air intake. Fortunately, it does not impinge on the aircraft structure to any extent, resulting in a reduced noise level in the cockpit.

The noise from the combustion chamber, turbine, and jet exhaust, extends aft from the tail-pipe exit in the form of a cone at approximately 45 deg to the engine center line. Where this cone intersects the aft portion of the fuselage there is a considerable increase in the general noise level. The greatest portion of this noise is composed of low-frequency high-energy components, and it should be possible by proper soundproofing to eliminate most of the objectionable frequencies.

The sound pressure level, due to aerodynamic sources, is greater at the lower altitudes because of the increased air density. At the operating altitudes of 30,000 to 40,000 ft, the general intensity level tends to fall off since the density is decreased. The greatest portion of the total noise at the cruising altitude originates from aerodynamic sources; the engine noise does not seem to have any appreciable effect on the total noise level at this altitude.

The high-frequency components of the sound can be attenuated by the use of fiberglas blankets. The low-frequency components can be attenuated only by the use of mica sheet or an equivalent material where vibration of the mica flakes can absorb the energy. This latter method is heavy and is not too efficient, as evidenced by present-day first-line transports.

Experience with the Comet, which was found relatively noisy in the aft end, cannot be accepted as a criterion of the final noise level since it is not as yet fully insulated and is not furnished with seats, carpets, curtains, etc.

### ECONOMIC CONSIDERATIONS

It is impossible to present a summary of economic analyses due to recent changes in Comet specification and performance data.

However, it is pointed out that the principal economic advantages to be gained through the operation of the turbine-powered Comet will be derived from two factors:

1 A substantial increase in utilization due to the increased speed. This increase will be in almost direct proportion to the speed and, in this particular instance, one Comet will do the work of two Canadair Four's. See Figs. 3 and 4.

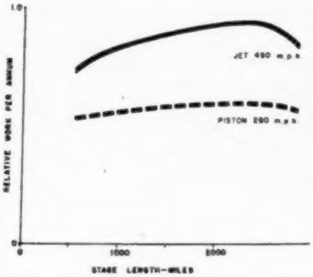


FIG. 3 RELATIVE WORK PER ANNUM VS. STAGE LENGTH

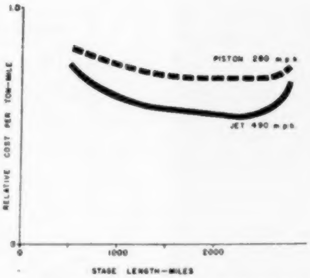


FIG. 4 RELATIVE COST PER TON-MILE VS. STAGE LENGTH

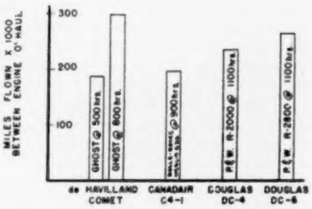


FIG. 5 MILES FLOWN BETWEEN ENGINE OVERHAUL VS. VARIOUS AIRCRAFT AND ENGINE COMBINATIONS

2 A major reduction in maintenance costs due to reduced vibration and to the simplicity of the basic design, the latter being derived in part through the elimination of such components as the propellers, cabin superchargers, cabin and thermal deicing heaters, and the like.

These factors have been estimated by various sources to effect an over-all saving of from 10 to 20 per cent.

In the first year of Comet operation no reduction is anticipated from present operating-cost level. This is illustrated in Fig. 5 for the aircraft and engine combinations which Canadian-Pacific operate. It is anticipated that the initial Ghost turbine overhaul period will be 500 hr for the first year, which will approximate the present Rolls-Royce Merlin 626 and Pratt & Whitney R2000 experience. In the second year a Ghost overhaul period of 800 hr is anticipated, which will surpass the present record of the DC-6 powered by Pratt & Whitney R2800 engines for work which was done between engine overhauls.

In view of the normal "learning period" which is experienced whenever a new aircraft is placed in service, the foregoing statements are a reasonable assumption. Subsequent to this learning period, it is felt that the forecast economies may be realized with the experience in hand and by the engine improvements now being type-tested by the manufacturer. It is believed that the Comet will be improved in range, speed, and power through steady development by the de Havilland Enterprises, and that it will adequately meet Canadian Pacific's requirements for the next 10 to 12 years.

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# TURBOJET AIRCRAFT

## *With Special Reference to the Jetliner*

By E. H. ATKIN

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This paper outlines the original target in the design of the Jetliner and gives the special design features which arise out of the use of the jet engine and the operating technique which is consequently required.

As can be seen in Fig. 1, the Jetliner is of quite conventional design. It is a low-wing monoplane having a low central fin with a tail plane mounted high on that fin. The engines are mounted in pairs in twin nacelles on either side of the fuselage, and these nacelles also serve to house the undercarriage.

### SPECIAL PROBLEMS

The Jetliner started out as an aircraft to fly ranges up to 500 miles with a pay load of 10,000 lb. This gave rise to an aircraft having a gross weight of the order of 55,000 lb. Powered by four Rolls-Royce Derwent 5 engines, the object was to provide a cruising speed of not less than 400 mph at 30,000 ft. Furthermore, the aircraft was to operate on runways not exceeding 5000 ft in length. The airplane has now developed, while retaining the same physical dimensions, into an aircraft which can be powered by one of several alternative jet engines, in addition to the Derwent 5, such as the J-33 or J-42 and with a take-off weight of the order of 70,000 lb depending upon the type of engine chosen; a landing weight of 60,000 lb, a pay load of up to 12,000 or 13,000 lb, a cruising speed of 450 mph at least, together with fuel capacity for still air ranges up to 2000 miles with a practical operational range of the order of 1000 miles. This has been achieved while retaining the desired landing and take-off characteristics which will enable the aircraft to get in and out of runways of between 5000 and 6000 ft. The stalling speed has remained comparative with those obtaining for other up-to-date postwar intercity aircraft, thus demonstrating that the jet aircraft need carry no penalty from this point of view. The additional range has permitted the aircraft to take advantage of a greater operating height under certain conditions up to 35,000 ft. The handling characteristics of the aircraft on the ground have proved to be quite normal. This is contrary to the doubts and fears of many people prior to the actual operation of a jet-transport prototype. It was

Contributed by the Aviation Division and presented at the Semi-Annual Meeting, Toronto, Ont., Canada, June 11-14, 1951, of The American Society of Mechanical Engineers. (Condensed.)

originally imagined that the terrific blast of hot gases from jet engines would make the jet transport extremely difficult to handle in the normal airport pattern from the ground personnel and passenger point of view, and it was thought that the aircraft would be difficult to maneuver. Furthermore, it was imagined that the noise from the jet engines would be highly objectionable. No doubt many of these forebodings could have been ruled out by a study of military jet aircraft, but this is always difficult, and in any case military aircraft are not limited by the landing and take-off requirements that have been laid down for civil aircraft, and do not afford the opportunity by operating in close association with airport procedure.

The operation of the Jetliner, particularly since the author's company started the long-range fuel-consumption trials which necessitated operating in and out of airports within the existing traffic pattern and procedure, has proved conclusively that these imagined difficulties are completely unfounded. The Jetliner has been taken into such airports as Chicago, New York, and Washington, to name the more congested, and has demonstrated that the approach procedure, maneuverability, and speed range of the aircraft are perfectly normal and no different from other aircraft; that the take-off and landing runs required are equal to or better than current types, and the handling ability of the aircraft on the ground is little different from that of the reciprocating-engine types. Furthermore the impact of the exhaust jets on the runway surface, passengers, and ground personnel, is not particularly detrimental. In fact, very little discretion on the part of the pilot is required in handling the throttles when coming in close with other aircraft without discomfort outside ~~the normal~~ distances outside of which people normally stay in the case of reciprocating-engine aircraft. This was particularly the case on one occasion at Idlewild Airport in New York, when the aircraft was turned quite close to the spectators on a very wet air field without throwing up mud, water, or having any other harmful effect. It has been indicated, however, that jet aircraft will require well-maintained concrete runways free from loose asphalt as this can well be lifted by the jet stream under take-off conditions and blown back from the runway.

As for noise, the general conclusion by airport authorities who have had the opportunity to study this question is that the noise from the jet aircraft is actually less objectionable and less intense in many ways than that at present emitted by reciprocating engines. Therefore, it can be said that the handling ability of the aircraft has been sufficiently demonstrated and that the special problem with regard to the jet transport is really the question of fuel economy, during taxiing,

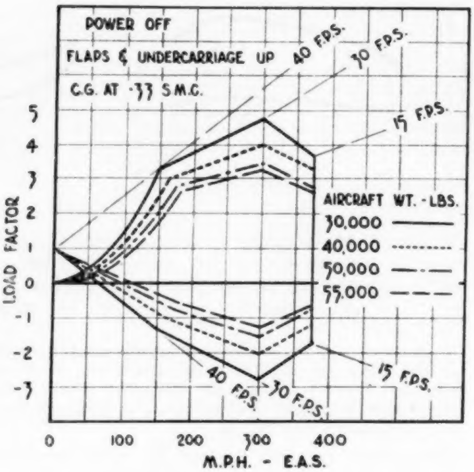


FIG. 2 EFFECT OF SPEED VS. LOAD FACTOR

run-up, and waiting for instructions to take off. Even this is probably a little exaggerated in many cases but experiments will have to be carried out in order to establish the degree to which it is desirable to either (*a*) take the aircraft out to the take-off point, or (*b*) take the passengers to the take-off point.

With regard to the run-up time prior to take-off, this is a much simpler procedure with the jet engine, and it should be possible to arrange that the engines need only be started at the time of receiving an instruction from the control tower, say, one minute before permission to take off is granted.

### SPECIAL FEATURES

The first special feature arising out of high-altitude operation of the jet transport is pressurization. The Jetliner has a completely automatic system capable of operating under chosen conditions up to a maximum pressure differential of 8.3 psi. This rather high pressure has been chosen for two reasons. First, it is desirable for the passengers to have the cabin altitude as low as is practicable, and 8.3 psi provides a 4000-ft cabin at 30,000 ft. This should be very acceptable to the passengers when compared to the present differential which gives cabin altitudes of the order of 8000 ft at 25,000 ft. The other reason, however, for this high differential is the importance of climbing and descending as rapidly as possible to and from the cruising height in the interests of fuel economy while submitting the passengers to as low an apparent rate of climb in the cabin as is feasible. The target for this was originally set at 200 fpm, and this low cabin rate of change of altitude can only be associated with a high rate of climb or descent for the aircraft if a high pressure differ-

FIG. 1 OVER-ALL VIEW OF JETLINER

ential is adopted. The use of 8.3 psi means that the structure must be tested for at least 16.6 psi and preferably more. This gives rise to considerable testing problems as the amount of stored energy of 16.6 in. in a fuselage having at least 4600 cu ft capacity is very great and failure can well be catastrophic. This gave rise to the technique of carrying out such tests in a large tank of water in order to minimize the damage when failures take place. Aircraft Ltd. were among the first people to use this technique. The pressure arising out of explosive decompression can also be quite devastating. This means that from a pressure point of view the fuselage structure must be as reliable as the wing itself.

### SPEED

The other factor influencing the structure of the aircraft is the speed at which the jet aircraft is intended to fly. This inevitably gives rise to special structural problems and definite methods of design and construction if the weight penalty associated with greater speed is to be minimized. In the case of the Jetliner a structure weight percentage in terms of the take-off gross of the order of 25 per cent speaks well for the job which the engineers have done. The stiffness of the structure also becomes increasingly important as the speeds go up and this also gives rise to special considerations and investigations as to the stiffnesses and natural frequencies of the various parts of the airframe. The effect of speed on the required strength of the aircraft structure is shown in Fig. 2.

### DEICING

The problem of deicing is not peculiar to jet aircraft. There is, however, one novel problem and that is the deicing of the jet engine itself. Until now the ease of deicing the centrifugal has been one of its great attractions in spite of the greater potential development of the axial-type engine. There is evidence, however, that considerable progress is being made with deicing of the axial-type engine. The complications arising out of the propjet combination from the deicing point of view are appreciably greater and there is the propeller to deice in addition to an intake which is more difficult to cope with.

### POWER PLANT

The Jetliner as presently designed is powered with Rolls-Royce Derwents. These are mounted in pairs in a carefully faired nacelle. This is shown in Fig. 3. The Derwent calls

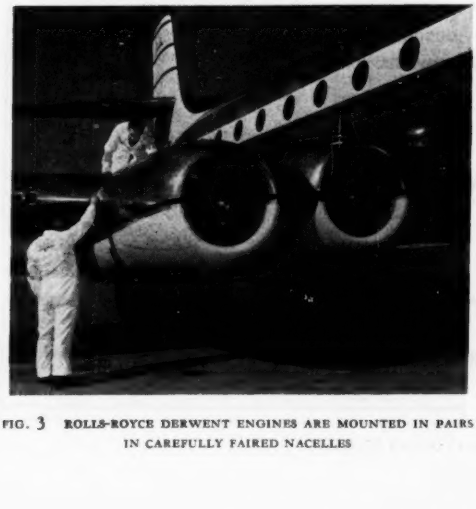

FIG. 3 ROLLS-ROYCE DERWENT ENGINES ARE MOUNTED IN PAIRS IN CAREFULLY FAIRED NACELLES

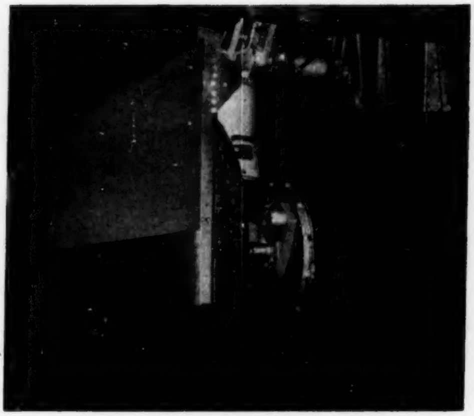

FIG. 4 ABSENCE OF PROPELLER RESULTS IN LIGHT COMPACT LANDING GEAR

for the plenum-chamber type of intake which, in the case of the Jetliner, has proved to be very efficient. A number of special problems had to be solved in connection with the cooling of the engine and its jet pipe, and the main design problem was the fire-detection and prevention system. Very few data were available on this subject and a great deal of investigation was carried out in order to establish a satisfactory system. The main problem was the greatly increased mass flow into the engine giving rise to a considerable increase in the fire-inhibiting requirements. It is felt that this part of the airplane is one where the great simplicity of the jet engine is exemplified. There is just no comparison between the simplicity of a jet-engine-nacelle installation and a reciprocating-engine installation. By comparison with the propjet installation, the elimination of the propeller with its associated reduction gears and other complications, gives the simple jet engine a considerable advantage.

The Jetliner is also fitted with water methanol thrust augmentation which is now common to gas-turbine and reciprocating engines. This provides up to 12 per cent increase in thrust under hot-day conditions in order to meet the take-off characteristics. The fuel tanks are not particularly unusual. To carry the large amount of fuel integral tanks have been found satisfactory up to this time. The landing gear is somewhat similar to that on other planes. It has the virtue of being compact and light because the absence of the propeller has kept the height of the aircraft from the ground to a minimum. This is shown in Fig. 4.

The remainder of the aircraft is similar to other postwar types. The main place where advantage is taken of the jet engine and absence of the propeller is in the cockpit, Fig. 5. This indicates the simplification which can be achieved if one can delete the propeller and other associated controls and a number of engine instruments normally required by the reciprocating engine. The Jetliner has been designed as an intercity aircraft for short to medium-range operation, and the cockpit is laid out for a captain and first officer only and all equipment required for the flying of the airplane can be operated from these two seats.

### AERODYNAMIC FEATURES

Aerodynamic features of the Jetliner which may be considered as peculiar to jet aircraft design are the unbalanced

FIG. 5 SIMPLIFIED COCKPIT LAYOUT OF JETLINER IS ACHIEVED WHEN PROPELLER AND OTHER CONTROLS ARE ELIMINATED

FIG. 6 AERODYNAMIC FEATURES INCLUDE UNBALANCED ELEVATOR AND AILERON AND RUDDER CONTROL SURFACES

control surfaces, particularly the unbalanced elevator and aileron and rudder control surfaces. These, are becoming increasingly a feature of high-speed flight. While the Jetliner cannot be said to be in the same speed bracket as the latest military aircraft, it was designed with a view to future development, and it is only by adopting as many high-speed features as possible that this development can be carried out. See Fig. 6.

In advancing the case for the jet transport probably the cleanness of the airflow over the airframe, unspoiled by the propeller, is the main point to mention. This gives rise to more effective controls, absence of extraneous antisymmetric effects, and a general smoothness over the cabin resulting in absence of vibration and a more pleasant and generally lower noise level throughout the greater part of the cabin length. There is, contrary to aircraft with propellers, a rise in noise toward the afterpart of the cabin. However, by adequate soundproofing treatment this need be no higher than that which obtains in the reciprocating-engine and turbine-propeller types. Throughout the remaining part of the cabin, which is usually three quarters of its length, the superiority of the jet from this point of view is outstanding.

### OPERATING ECONOMY AND TECHNIQUE

The jet transport is competitive economically with existing types of aircraft for the following reasons:

It has greater speed combined with the use of cheaper fuel;

(Continued on page 798)

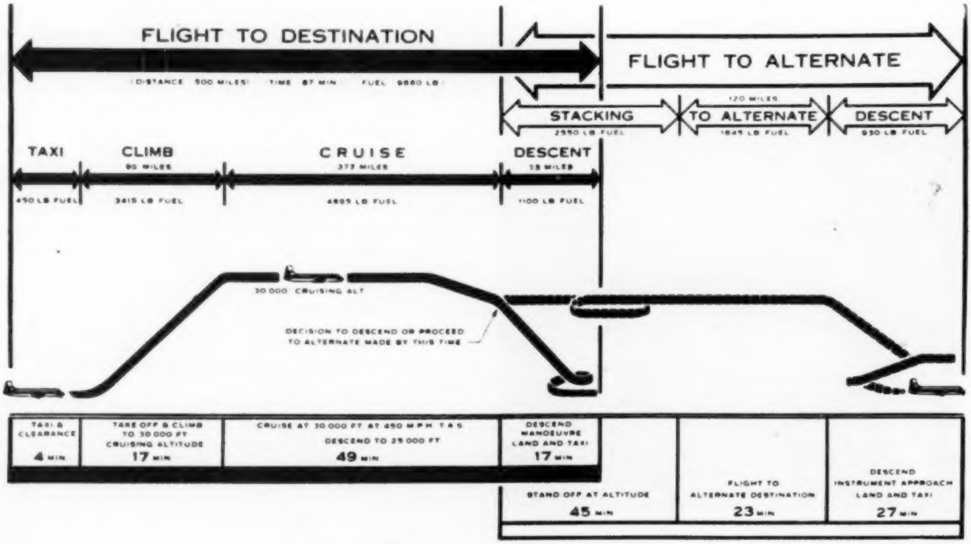


FIG. 7 TYPICAL JET FLIGHT PLAN FOR 500 MILES

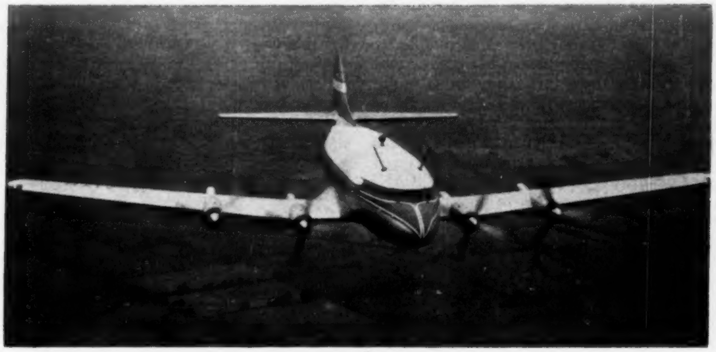

FIG. 1 ARMSTRONG WHITWORTH TURBOPROP APOLLO CIVIL TRANSPORT IN FLIGHT

# PROPELLER-TURBINE AIRCRAFT

## *With Special Reference to the Apollo*


By H. R. WATSON

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THIS paper discusses the advantages and disadvantages of propeller-turbined aircraft as compared with aircraft using other types of engines and also gives a brief description of the Apollo including a few of its special features.

The Armstrong Whitworth Apollo, see Fig. 1, is a 26 to 31-seat medium-range low-wing turboprop monoplane having a take-off weight of 45,000 lb and a landing weight up to 43,000 lb. Powered by either four 1000-hp Armstrong Siddeley Mamba engines or four 1270-hp Armstrong Siddeley Mambas, the Apollo has a pay load of 7000 lb. Other particulars are as follows: span, 92 ft; length, 71.5 ft; height, 26 ft; wing area, 986 sq ft; fuel capacity, 974 imp gal (1170 U.S. gal); flaps, slotted type with split operation under wing cuffs; maximum-lift coefficient, flapped = 2.4, unflapped = 1.7; flap stalling speed at maximum landing weight, 84 mph; undercarriage, twin-wheeled tricycle-type with steerable nose wheel.

### COMFORT

That the low noise level and absence of vibration makes propeller-turbine aircraft greatly superior to piston-engined aircraft, is now universally admitted and for this reason alone the propeller-turbine has, in the author's opinion, an assured future in passenger transport. Comparison with the pure jet on noise level is clearly less decisive, the governing consideration being the propeller tip speed used on the turbine at cruising rpm. On the Apollo the rotational tip speed is kept below 720 fps by using a four-bladed propeller, 10 ft in diam in conjunction with a 0.097 reduction gear. A careful choice is necessary on these points as the propeller-turbine starts with an inherent disadvantage because of the high ratio of cruising rpm to maximum rpm as compared with the piston engine. An increase in the number of blades is an obvious device to keep down tip speed. The Apollo was fitted initially with three-bladed propellers because it was thought that four-bladed roots would cause an undue obstruction to the relatively small annular intake, but experience has shown that this is not the case.

The Apollo is fitted with armchair-type seats arranged in pairs at a 40-in. pitch, large-area nonmisting windows, two wash rooms with hot and cold running water, fluorescent lighting for night flight, and a galley equipped for the preparation of cooked meals.

The entire accommodation, including underfloor baggage compartments, is fully air-conditioned and pressurized to $5^1/_2$ psi, giving a maximum cabin altitude of 8000 ft at true heights up to 25,000 ft.

### PERFORMANCE FEATURES AFFECTING SAFETY

For take-off safety the propeller-turbine aircraft appears to be in an unrivaled position. The engines are essentially unsupercharged in their characteristics, and the shaft horsepower at constant forward speed varies roughly as the relative density of the ambient atmosphere to the power 0.9. It follows that an aircraft fitted with such engines, when designed to have adequate cruising speed at altitude, will tend to have ample power at sea level. As a rough rule based on experience with the Apollo, it may be assumed that if a four-engined aircraft has sufficient power to cruise at 1.3 × minimum drag speed at 20,000 ft, it will also have sufficient power to meet all British Civil Airworthiness Requirements (BCAR) and International Civil Aviation Organization (ICAO) requirements for take-off including the appropriate engine-cut case. If the design cruising altitude is 25,000 ft as in the case of the Apollo with 1270-hp engines, then the power at sea level may be sufficient to meet the requirements at the lower rpm corresponding to maximum continuous power. This could be regarded as constituting a very real advance in safety. The complex regu-


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lations covering take-off and landing must convince all designers that these are the most hazardous, or should we say, the least safe periods of flight. Surely, then, it is completely illogical to drive the engines harder during these critical periods than at any other time during the flight. Only necessity can justify such a course but this necessity is nearly always present for both piston and jet-engined aircraft, unless we resort to some form of assisted take-off. Unfortunately, although the propeller-turbine starts with an ample power margin at take-off under International Commission for Air Navigation (ICAN) conditions, there is a serious depreciation of power with increase of ambient temperature. This is approximately 0.8 per cent power reduction for every extra degree centigrade, assuming a constant jet-pipe temperature.

A high power at sea level is also an additional safety factor in the event of a balked landing and the Apollo could climb away on three 1270-hp engines at 900 fpm without raising the flap from the landing position or retracting the undercarriage. This rate of climb refers to the maximum landing weight of 43,000 lb but even at take-off weight the climb could be maintained at a lower rate. With flaps and undercarriage retracted a low altitude can be maintained on a single inboard engine.

This leads to the general question of cruising with one or more engines inoperative.

In the early days of civil aviation it was customary to think in terms of ability to maintain height after an engine failure

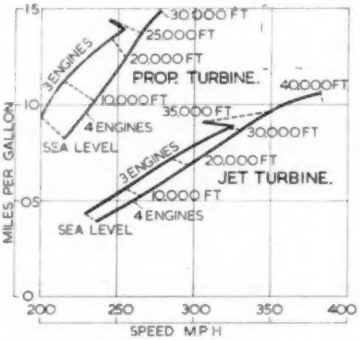


FIG. 2 EFFECT OF LOSS OF 25 PER CENT TOTAL POWER—PROPELLER TURBINE VERSUS JET TURBINE

while selecting the nearest convenient landing field. It is now necessary to maintain range as well as height. The pure jet aircraft can only do this by having engines of sufficient size to give a power margin at the design cruising conditions. Otherwise an engine failure involves the reduction of true speed or an increase of drag by maintaining speed at a lower altitude, and in either case the range is likely to be reduced considerably.

A propeller-turbine, on the other hand, can suffer an engine failure and reduce both height and speed with a much smaller sacrifice of range. Such range reduction as there is, will be due to the reduced propulsive efficiency of that part of the power provided by the jet. There is no other penalty arising from reduced true speed except in the presence of a head wind. The relative effect on air-miles per gallon of a failure of one quarter of the total power is shown for both types of engine in Fig. 2.

### SPEED

It must be admitted at the outset that the propeller-turbine aircraft is not comparable to the jet when speed is the primary objective regardless of cost and range, as is often the case for military aircraft. Work is in hand on the supersonic propeller but this has not yet "arrived" and is considered beyond the scope of this paper. In general, there is a sharp drop in propeller efficiency for aircraft Mach numbers above 0.7. It is, of course, difficult to design a civil aircraft with an acceptable cruising drag at Mach numbers above 0.7, and the jet aircraft in particular will tend to need the high critical speed of a thin wing and the fuel capacity of a thick one. Avro Canada's Jetliner appears to be an effective compromise.

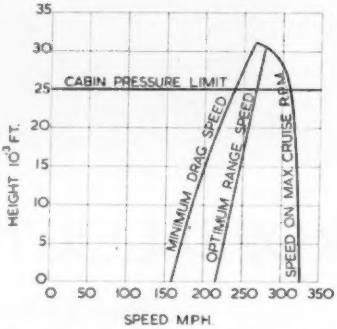


FIG. 3 SPEED VS. HEIGHT—APOLLO AIRCRAFT

The Apollo with 1270-hp engines has a speed on maximum continuous power of 310 mph true at 25,000 ft. This is 1.3 × the speed of least drag and is thus not far from the speed of optimum range, which occurs at about 1.1 × least drag speed. Fig. 3 shows that the speed on maximum continuous power and the optimum range speed are approaching each other as the height increases. At the design cruising altitude of 25,000 ft the rate of climb available is up to 400 fpm. While a higher speed could no doubt be usefully employed, it is felt that only modest time savings could be effected by using greater power on an aircraft of relatively short range.

### RANGE

The first quality required of any civil aircraft engine is reliability, but this is now so taken for granted, that an aircraft designer's first thought on choosing an engine, is nearly always related to its fuel consumption. For a given quantity of fuel, the propeller-turbine has a shaft horsepower which increases slightly with forward speed, and a falling net jet thrust. The total output of the engine will thus vary with speed and height in a somewhat complex fashion, whether we adopt thrust or horsepower as a common denominator for the two parts of the total output. Any quotation of fuel consumption must therefore be closely related to a particular set of conditions. For the Apollo, cruising at maximum continuous power with 1270-hp engines at 25,000 ft, the fuel consumption is 0.90 lb per thrust hp-hr. The piston engine which would no doubt require a fair degree of supercharging at this height, would probably give about 0.60 lb per thrust hphr. For several reasons, however, the outlook for the propeller turbine is by no means as gloomy as this 1.5 to 1 ratio would suggest. For example, the small nacelle diameter gives a substantial drag reduction in comparison with a piston engine of corresponding power. (Both 1000-hp and 1270-hp Mambas have an outside cowl diameter of 31 in. and cooling drag is of course eliminated.) The parasite-drag coefficient actually measured in flight on the Apollo is 0.019, with piston engines of corresponding power it is estimated that this value would increase

by at least 15 per cent to 0.022. An even more important factor is that the installed weight is considerably less for the turbine than for the piston engine.

A basis for comparing different types of engine which takes into account the differences in weight drag and fuel consumption is not easily found. Fig. 4 shows two imaginary aircraft based on the Apollo. One has four Mamba 1270-hp engines and the other has a fractional number of a typical type of piston engine.

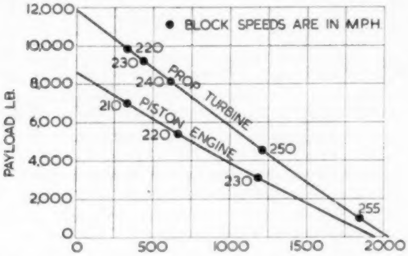


FIG. 4 PAY LOAD VS. STAGE LENGTH—PROPELLER TURBINE COMPARED WITH PISTON ENGINE

Fuel and pay load are assumed interchangeable regardless of structural strength or fuselage capacity, while the take-off weight is kept the same in both cases. The cruising altitude is taken as 25,000 ft. It will be seen that the superiority of the propeller-turbine covers all stage lengths up to 2000 miles. The piston-engined aircraft is allowed the advantage of flying close to its optimum range speed which is lower than that of the turbine. Many methods could be devised for making this comparison and would no doubt yield many different answers. It is hoped that Fig. 4 will prove near the truth at the present stage of development. At least it shows the general trend of the comparison.

It may be argued that the conclusions of Fig. 4 are invalid because the pay load is zero at the point where the two curves intersect.

The vertical intercept between the two curves represents the difference in the installed weights of the two types of engines, less the difference in fuel margins required (i.e., taking into account the fact that zero range does not coincide with zero fuel). The slope of each curve is governed by the air-miles per gallon with the appropriate engines. The range at which the intersection occurs is thus independent of the absolute value of pay load. The absolute value of the Apollo pay load as shown, is restricted first because the aircraft is lavishly equipped and second because the take-off weight, on the prototypes only, is artificially restricted by the structural strength.

The conclusion to be drawn is that the turbine aircraft is superior for short or medium ranges, but that the piston engine is still supreme over all other types of engine when long range is required, without an over-riding demand for speed. No doubt the newer turbines will improve rapidly as all new types have done in the past, but the enthusiasts who regard the reciprocating engine as dead (and many of them said so two years ago) are, at least in the author's opinion, premature.

The methods of estimating stage length used by the Society of British Aircraft Constructors (SBAC) fall with some severity on short and medium-range aircraft. The result is that only about 60 per cent of the total fuel is effectively used in moving the aircraft along its stage length and that the stage length is only 60 per cent of the absolute range.

STACKING

Part of the 40 per cent fuel, which serves only as an insurance on flights which proceed with no unforeseen incident, is an allowance for 45 min stacking at 2000 ft. It was pointed out that the Apollo could reduce height and speed without serious loss of range in the event of engine failure. If, however, it is desired to fly with all engines operative at a very low altitude, both range and endurance will suffer because the engines are throttled back to the point where their specific consumption is high.

Stacking is therefore carried out on the two inboard engines with the remaining engines feathered. Should one of the two operative engines fail suddenly, it is considered that there would be ample time to unfeather and relight one of the other engines, at a height of 2000 ft. The optimum endurance on two engines is approximately 1.4 times that with four engines, on any given quantity of fuel at this height.

CONTROL AND STABILITY

The problems which have to be solved under this heading are not fundamentally different on the Apollo from corresponding problems on other types of civil aircraft. The unusually high sea-level take-off power already referred to does mean, however, that certain difficulties are encountered in their most acute form.

The rudder is one of these problems. In the event of an engine failure at take-off, the high power not only operates directly in providing a high asymmetric thrust but also compels a large propeller diameter and hence an outboard engine which is relatively far from the aircraft center line. In addition, the operator requires a large-diameter fuselage which will contain two double seats abreast and a central gangway. This tends to shorten the cabin and makes it desirable to use a short fuselage to economize in weight. This results in a short rudder arm and a high rudder load. It was originally intended to deal

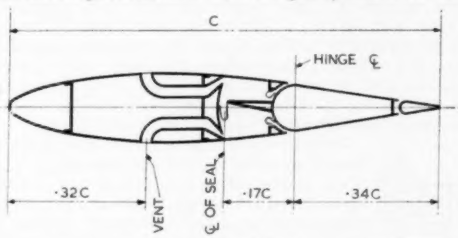


FIG. 5 THREE-SEAL (IRVING) ELEVATOR BALANCE

with this problem by a partly power-operated rudder, but the general state of power control development was not sufficiently far advanced when the aircraft was designed, and the idea was therefore abandoned.

The required foot loads after an inboard engine failure must be limited to 180 lb before trimming out, and 50 lb afterward. To achieve this it was necessary to adjust the shielded horn balance until the rate of change of hinge moment coefficient with angle ($b_2$) was as low as —0.06 at small angles even with 1000-hp engines. This is only part of the difficulty as the close balance tends to exaggerate any deficiency associated with side slip.

The rate of change of hinge moment with yaw is notoriously nonuniform with most types of balance; the general tendency being a change from positive at small angles to negative at large angles.

With an excessively positive value at small angles, we encounter a slow yawing oscillation in "straight" flight with rudder free which is generally known as tramping. With an excessively negative value at large angles, rudder locking will

tend to occur at the high angles of side slip which such a powerful rudder is inevitably capable of producing. For the lower-powered Mambas this problem was successfully solved by combining the effect of a shielded horn balance and a large tab using a nonlinear gearing. For the larger engines, however, it was found essential to supplement the geared tab with a small spring tab of the usual torsion bar type. It is emphasized that the problem is by no means a simple one even on an aircraft of moderate size.

Adequate pitching stability is another major problem. The turbine pays for its low frontal area to some extent by an increase of length, particularly in comparison with a radial engine, and on a medium size of wing it is convenient if not essential to place all but the tail pipe forward of the front spar. The propeller lift effect is thus well forward of the center of gravity and this, in combination with the high-engine performance, gives a power destabilization at climbing speed of about 0.10 chords at sea level. It is thus of special importance to get the most out of the tail plane and elevator, both stick fixed and stick free.

The Apollo elevator balance is of the shrouded type usually referred to in England as the Irving balance. It is sealed with rubberized fabric at the balance leading edge and at the two hinge gaps, with pipes leading forward from the balance chambers to approximately $^1/_3$ chord of the tail plane, Fig. 5. Few applications of the three-seal balance are in use on British aircraft but we have found them successful, subject to sufficient care in avoiding friction on the seals. This arrangement shows no loss of stability on freeing the stick.

One other stability difficulty is dealt with briefly as the solution is believed to be new. The dual-control columns, one of which carries an extra wheel for ground steering, were found to exert substantial weight moments about their common cross shaft. These moments were of course subject to change both by control-column displacement and by changes of aircraft attitude. At the bottom end of the speed range this gave a destabilizing effect of about 0.04 chord. One obvious solution is to provide simple static balance about the bottom cross shaft, but space does not allow a long lever for the balance and the weight required would therefore be excessive.

The next solution is a geared mass balance. Using a gear ratio of $n$ to 1 and choosing a weight which is just sufficient to balance the columns against an attitude change, we find that for balance against control-column displacement relative to the aircraft, the balance weight is approximately $n$ times too big. The final design, therefore, consists of two weights one placed above its pivot and the other below its pivot so that their sum operates against an attitude change and their difference against a column displacement, Fig. 6. Two simultaneous equations will now determine the weight for any particular balancing system.

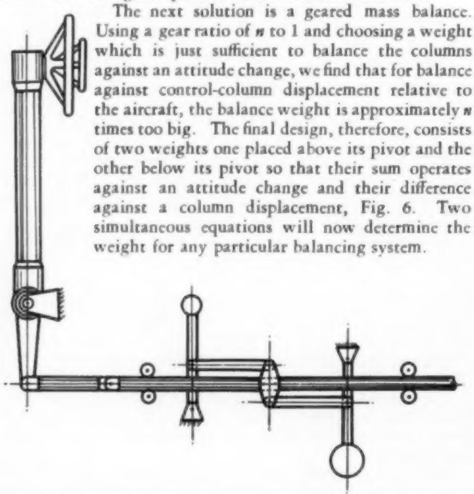

FIG. 6 CONTROL-COLUMN BALANCE OF THE APOLLO AIRCRAFT SHOWN IN NEUTRAL ATTITUDE

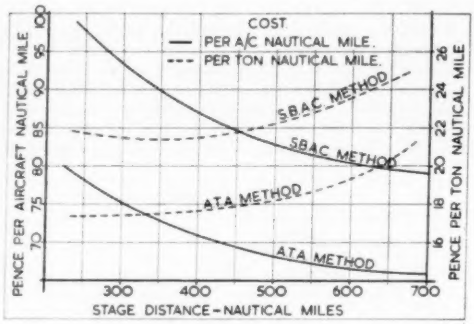


FIG. 7 OPERATING ECONOMICS OF THE APOLLO AIRCRAFT—COST VERSUS STAGE LENGTH

### OPERATING COST

Aircraft powered by propeller-turbines, lacking the low specific consumption of the piston engine and the high cruising speed of the pure jet, have often been condemned on the grounds of economy. Recent test experience with British turboprop aircraft has proved that they can compare favorably in this respect.

Fig. 7 shows the variation of direct operating cost with stage distance. It should be noted that no landing costs are included in the Air Transport Association of America (ATA) method.

### CONCLUSIONS

The propeller-turbine aircraft offers outstanding advantages in passenger comfort and, even at the present stage of development, such aircraft can compete effectively in their ratio of pay load to take-off weight for stage lengths up to 2000 statute miles.

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## Turbojet Aircraft

*(Continued from page 794)*

its appreciably greater simplicity resulting in reduced operating costs offset the increased fuel consumption and so enable the jet transport to compare favorably with existing types. To do this the jet transport must fly high in order to achieve fuel economy, and in this it is similar to the turbine-propeller aircraft. As a result of much investigation, it has been demonstrated that the Jetliner or any other jet transport can be operated economically with adequate pay load, and at the same time carry fuel reserves which meet all normal airline requirements. A typical operation is shown in Fig. 7.

This illustrates the various parts of the operation which have to be considered and the way the operation should be carried out in order to achieve maximum fuel economy. The factors involved are brought out best by evaluating the aircraft in passenger miles per year as the product of the block speed and passenger capacity. If we accept the approximation that the present-day jet engine consumes 70 per cent more fuel than the propeller-turbine aircraft, and 160 per cent more fuel than a reciprocating-engine aircraft, while the jet fuel is roughly two thirds the cost of the reciprocating-engine fuel, then it can be seen that the cost per mile is approximately the same. In other words, the jet aircraft is competitive with the other types while having the added advantage of increased speed and comfort

# THE FLYING BOAT

## *With Special Reference to the Princess*


By HENRY KNOWLER

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IN a recent Wilbur Wright lecture[1] it was pointed out that the trend in all forms of public transport is toward the largest unit which can be operated until increase is restricted by factors other than the vehicle itself; thus omnibuses grow in size until the street width or the radius at corners check further increase; in a similar way, railway rolling stock is artificially restricted in size to the largest unit which can safely use the track and pass through tunnels, etc. When, as in marine transport, such restrictions are nonexistent, we see the unit increase to immense sizes as evidenced by the "Queens."[2]

### TRENDS IN SIZE OF AIRCRAFT

The reason for this trend in size is an economic one, the largest unit having invariably proved to be the most efficient. A similar trend in size is found with aircraft although, due to runway restrictions and other reasons, there is at present a temporary check. However, there seems to be no reason to suspect that the limiting size has yet been reached, particularly in the case of the flying boat where it can be stated, with certainty, that the ultimate size cannot yet be seen. In the latter case, therefore, we can approach development without restrictive size complexes. Quite apart from this philosophy, our studies into the type of aircraft to suit very long stages, such as the nonstop North Atlantic service, show that the claim for greater efficiency with size increase is substantiated.

One of the arguments supporting these claims, for instance, is that the profile drag improves with size, due to (1) the trend toward higher wing loading; (2) proportionately smaller body surface area is required to contain the pay load since this area varies at two-thirds power of the volume; (3) parasitic and interference drag can be more easily reduced; and (4) the frontal area of the power plant does not increase proportionately with power.

Again, the arguments for weight saving with size increase, which is well substantiated, are possibly due to some or all of the following reasons: (1) the higher wing loading just mentioned becomes an important factor in the control of wing weight tending to offset the penalty of increased span; (2) materials of higher specific strength and greater substance are probably more easily incorporated in the construction of the aircraft; (3) greater economy is exercised in the assessment of the design loads to be applied although the benefits of this may be tempered by the effect of the slower response of the large aircraft to disturbance and maneuvering. At the same time, greater care is exercised in detail design; and (4) there are many weight items common to all aircraft.

Proof of the foregoing statement is contained in the curves

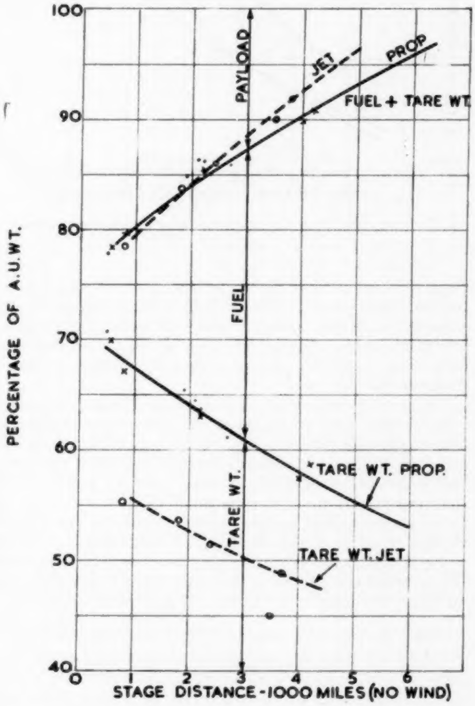


FIG. 1 VARIATION OF WEIGHT PERCENTAGE AND STAGE DISTANCE FOR DIFFERENT AIRCRAFT

of Fig. 1. The data used in constructing these curves have been derived from the performance of a number of modern aircraft fitted with different types of power plant. The curves show the variation of the percentage tare weight, fuel, and capacity pay load plotted against range. This range is for still-air conditions and the fuel load includes allowances for the particular stage distance plus reserves for 0.75 hr standoff or flight to alternate—the reserves are, however, assumed to be unused.

Fig. 1 shows that, as the range increases, and because of the use of a larger aircraft, the tare weight percentage shows a steady trend toward a lower percentage of the all-up weight, while the expected increase in fuel percentage shows a tendency to improvement due to the favorable size factors. This curve, in fact, shows structural and aerodynamic efficiency as the range, and, consequently, the size increases. On the same

[1] The 36th Wilbur Wright Memorial Lecture read before the Royal Aeronautical Society on May 27, 1948, entitled "Size in Transport," by Sir Arthur Gouge, B.Sc., F.R.Ae.S.

[2] R.M.S. *Queen Mary* and *Queen Elizabeth*.


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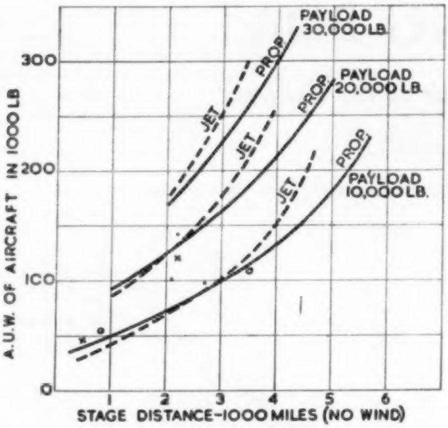


FIG. 2 VARIATION OF A.U.W. AND STAGE DISTANCE FOR DIFFERENT AIRCRAFT

graph a dotted curve shows the improved tare weight associated with jet-engined civil aircraft but the large amount of fuel required for a given journey is also indicated. Nevertheless, over short ranges, a greater pay load can be carried and only when long ranges are necessary, does the relative transport efficiency fall.

This graph gives no clue to the size of aircraft but experience indicates that for a longer range, the aircraft must be larger, and the pay load greater. Fig. 2 gives some indication of the present trend in size of aircraft required to carry a given pay load over varying stages. Although, due to variations in numerous factors there may be small differences from these curves when checked against individual aircraft, the general trend is true. It is clear from Fig. 1 that the pay load, in terms of percentage all-up weight, decreases with range but the operational economy of the larger aircraft is restored by virtue of the higher over-all efficiency previously discussed.

#### OPERATING COSTS OF AIRCRAFT FITTED WITH VARIOUS ENGINES

Taking the foregoing into account, a comparison has been made on a generalized basis of the relative direct operating cost of aircraft fitted with reciprocating, propeller-turbine, and jet power plants. The performance of each type has been estimated for aircraft designed for operation over specific ranges in such a way as to obtain maximum transport efficiency. A study was made in some detail, including the main contributory factors in the direct cost of operation. The fuel has been costed directly and includes a factor to cover the different fuels used.

The resulting curves of Fig. 3, as would be expected, show that the longer the range, the more the unit cost, but the particular interest in these curves lies in the relative costs of the three types of power plant.

It will be seen that the increased block speed of the propeller-turbined aircraft reduces the direct operating cost below that for the piston-engined aircraft but for the shorter stage distances and for the same reason, the jet aircraft shows up as the most economical. On increasing the stage distance, however, the jet-aircraft advantage disappears and the propeller-turbined aircraft provided the greater efficiency.

An approximate assessment of the stage distances from England to Gander and from England to New York with appropriate allowances for wind and alternate shows that 3500 miles and 4500 miles, respectively, are required on this graph. The propeller-turbined aircraft, therefore, operating on the direct journey, costs approximately 1d. more per ton/mile than the jet aircraft with its necessary refueling landing at Gander. The cost of this landing at Gander must, however, be added to the operating cost and the result is that, on the basis of over-all costing, the balance is in favor of direct flight.

It is indicated that high block speed is an advantage to direct operating costs and has also the obvious effect of reducing the journey time. This is so only if the journey is nonstop. An intermediate refueling stop can negate this benefit since the total journey time must include the time spent in refueling. In fact, it can be shown that an aircraft on the North Atlantic route, flying direct to New York at a cruising speed of, say,

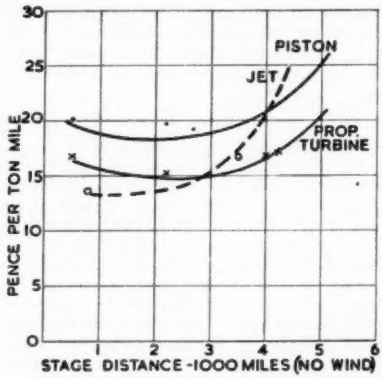


FIG. 3 VARIATION OF COST PER TON/MILE WITH STAGE DISTANCE FOR THREE TYPES OF POWER PLANT

380 mph, has the same over-all block speed for the total journey as that achieved by an aircraft with a cruising speed of 500 mph but requiring a refueling stop at Gander.

#### QUALITIES DESIRABLE IN AN AIRCRAFT

Having discussed the design efficiency associated with a large aircraft, it is important to consider what qualities in air travel the passenger will require in the future and what will attract him to a particular airline.

It is suggested that the following qualities are desirable: smooth ride, short time of journey, quietness, and creature comfort.

The smooth ride is placed first since the reverse has the greatest ill effect on the passenger's comfort. The best way to achieve this is to fly in the stratosphere since atmospheric conditions at high altitude are likely to be the most stable. A hardly less important improvement can be obtained by reduction in vibration, and unusual movements due to control or stability. The former can, of course, be obtained by the use of turbine engines.

The second quality was stated as time of journey rather than speed, since a really fast machine may still have a low block speed over a given journey due to the necessity for a landing for refueling. This matter has been referred to in a preceding paragraph. Numerous cases will occur where a landing which is now made purely for the purpose of refueling can be avoided by the adoption of long-range types.

Quietness, the third quality of comfort, is probably attained easier on a large aircraft since the average seat distance from the source of noise is greater than with a small aircraft. Propeller turbines reduce power-plant noise considerably but the propeller tip speed must be considered and, also, the tip distance from the fuselage side. There are additional sources of noise which exist in a modern aircraft, such as air conditioning, recirculating fans, and other electrical equipment which is running continuously. It is easier to isolate these noises in the larger aircraft.

We turn now to the heading of creature comfort. The duration of a journey may vary from less than an hour to a multistage one of a day or two. The longer journeys are frequently boring and may be very fatiguing and it is considered that for those lasting five hours or more, there should be a greater degree of comfort than at present provided. Progressive comfort with duration of journey is already estab-

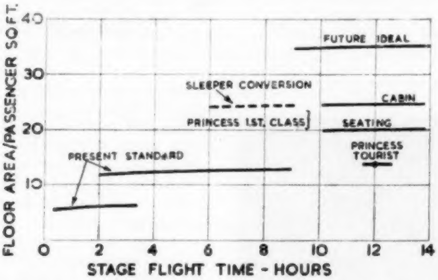


FIG. 4 VARIATION OF FLOOR AREA PER PASSENGER WITH TIME OF FLIGHT

lished in other forms of transport but in air travel there is at present little difference in the degree of comfort offered to passengers over a wide range of journey times. This can be seen in Fig. 4 where the comfort index of floor area per passenger is plotted for varying durations on scheduled flights. It is indicated that, except in sleeper conversions, the comfort standard is the same for journeys of from two to nine hours.

Travelers who have experienced flights in flying boats such as the Short Empire boats, Solents, or Boeing 314, recount with pleasure the journey they have made. Seldom do we find enthusiasm for the tube-train comfort of the conventional land-plane fuselage. If we analyze the reasons why the passengers enjoyed their flying-boat journeys, we find that it is because they were not confined to their seats, that there is a lounge/bar in which they can meet other travelers, and that the catering standard was of a high order. The provision of comfortable seats with wide spacing is an obvious requirement. However, when the backs of seats are inclined, it becomes awkward for the passengers in the seats directly behind. If we look to the somewhat unattainable ideal, a passenger should be provided with a lounge seat, a sleeping berth, and a share in a lounge/bar and the dining cabin. In addition, ample dressing room and lavatory space should also be provided. Some of these specifications have been met on the Princess flying boat.

It is established from the foregoing that for long-stage journeys a large aircraft is necessary, and that economic operation can be achieved. Furthermore, the large aircraft will have the increased volume which must be provided to insure passenger comfort, thus assisting the creation of the prestige service essential for high-load-factor operation.

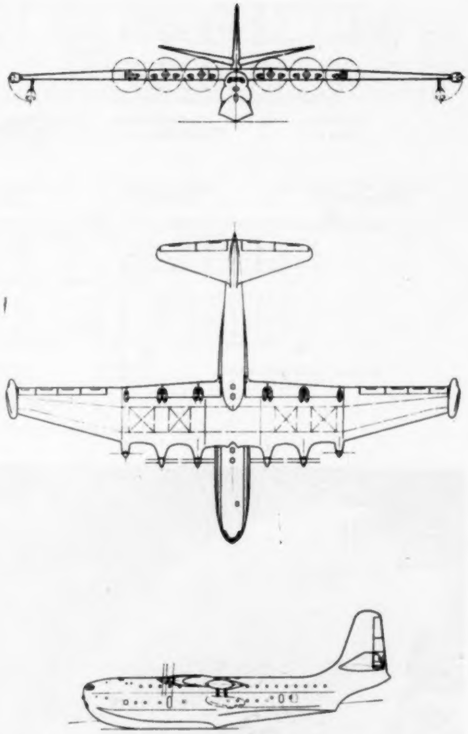

FIG. 5 GENERAL ARRANGEMENT OF THE PRINCESS FLYING BOAT

A land plane of large size calls for excessively long and strong runways. These are costly to build and maintain and are necessarily limited in number throughout the world. The large land plane, therefore, is restricted to certain routes where facilities are available and it appears that under present conditions, the limit in size has practically been reached. No such problems confront the big flying boat, which, with the provision of relatively inexpensive facilities, can be operated on most of the main international trunk routes.

On the main air routes of the world there are a number of transocean stages requiring fuel for an equivalent still-air range of some 5000 miles, an obvious example being the England-New York flight. On the basis of previous arguments it is clear that such flights require the use of propeller-turbine engines which satisfy the requirements of economy by virtue of their high-altitude high-speed operation.

The foregoing generalizations lead to a description of the Princess flying boat shown in Fig. 5. It has a take-off weight of 330,000 lb and is powered with four coupled Proteus and two single Proteus engines, giving an equivalent power loading for take-off, ICAN, of 9.5 ehp. The wings have an aspect ratio of 8.75, and, with an area of 5000 sq ft, give a wing load of 66 lb per sq ft.

PASSENGER ACCOMMODATION

A plan of the cabin layout for 105 passengers is shown in Fig. 6. The arrangement is intended to cater to two passenger

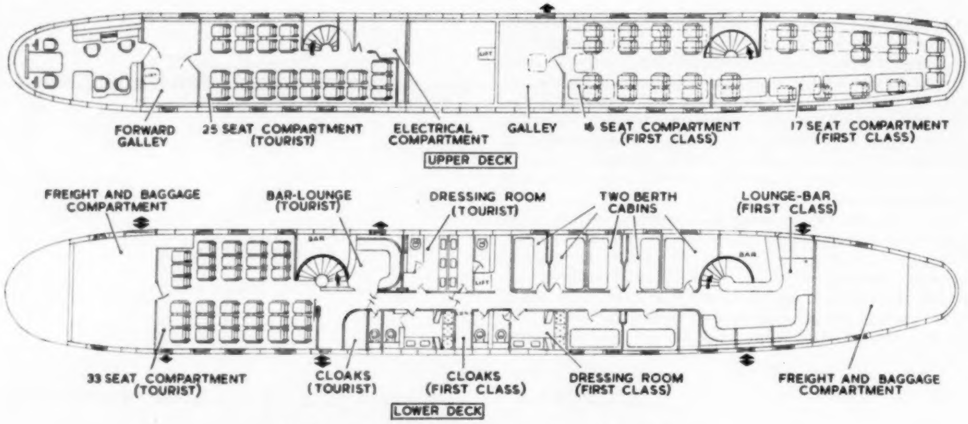


FIG. 6 INTERIOR LAYOUT OF THE PRINCESS FLYING BOAT

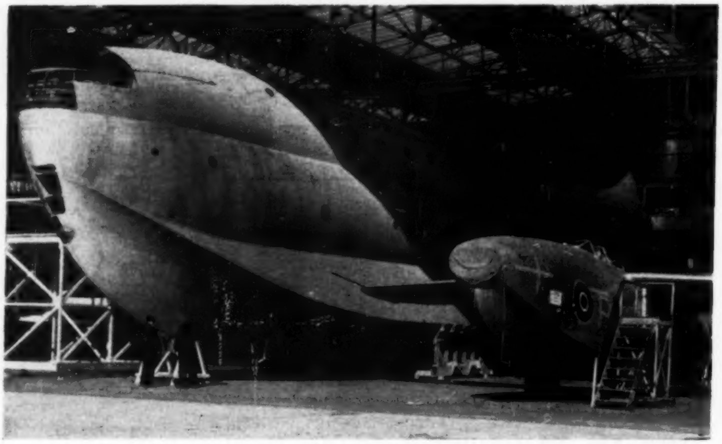

FIG. 7 BOW VIEW OF PRINCESS HULL ON THE STOCKS

classes, the policy being to provide extra facilities and comfort for the first-class while the tourist-class passenger will have a similar standard to that provided in existing aircraft. Thirty-three tourist-class passengers are accommodated forward of the wings on the lower deck and 25 on the upper. They have their own lounge/bar and are served from a tourist-class galley. Two dressing rooms are also provided.

In the first-class accommodation, seven two-berth cabins, convertible for seating in the daytime, are placed on the lower deck with a large lounge/bar situated aft. On the upper deck aft of the wing, siesta seating with full leg room is provided for 33 passengers. For flights at night there are 14 hinge-down bunks. The first-class accommodation also includes a large galley and two additional dressing rooms.

The styling and furnishing generally, as is appropriate to this size of transport, was intended to give a feeling of luxury. Study of the layout plan will show that thought has been given to the provision of ample stowage for stores, blankets, etc., and extra cloak-hanging space is available. A public-address system is provided for all compartments and provision made for music to be relayed.

In this layout, a baggage and freight compartment is situated both forward and aft, providing a total capacity of 18,900 lb; thus the capacity pay load of the aircraft will be 37,160 lb, with this particular accommodation plan.

#### CONCLUSIONS

In summary, it is probable that refueling stops at other than traffic centers will eventually disappear in order to reduce the journey time on main trunk routes to avoid inconvenience to passengers. Even at this time, a journey such as that from England to New York can be scheduled for direct flight without increased operating cost, provided very large aircraft are used. Further, it is considered that the future of big aircraft lies with the flying boats since it avoids airport-runway difficulties as well as having other advantages. The big long-range flying boat need not suffer from preconceived disadvantages such as high drag and weight. On the other hand, it meets the needs of the passenger of the future who will demand increased comfort as well as reduced journey time. The Princess, it is considered, fits well into the future picture having all the attributes which have been discussed, including speed, comfort, and independence of air-field development, as well as the capability of low operating cost. Also, because of its size, it will be in a position to meet an increasing traffic potential, and obtain a fair share of the latter. The prestige associated with the big flying boat will insure high load factors in a highly competitive market.

# FORGING MUNITION SHELLS

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THE Korean "Police Action" and the threat of another World War have revived interest in the production of high-explosive shells, mainly in sizes up to 155 mm diam.

The first general step in the production of artillery shells consists in forging billets or slugs to a hollow, almost cylindrical, shape. The slightly tapered cavity must be forged to finished dimensions, because it is not machined after the forging operation has been completed. In prevailing practice, shells are shaped at bright-red heat. All the steps which are required for making shell forgings from 75 to 240 mm were described and illustrated in two reports prepared by the Society.[1]

The author wrote these reports with the help of several able assistants and under the guidance of a well-informed ASME Committee. It will pay to review and evaluate these reports at the present time, because at the time of writing them, we were so close to the work that we could not see the woods on account of the trees.

#### SHELL-FORGING PROCESSES

Shell forging involves several steps, namely, dividing long mill-length billets (usually square with rounded corners) into shorter billets or slugs, heating the slugs to a uniform temperature, descaling them, and finally forging them into shape.

Let us assume that the slugs have been uniformly heated and that they have been descaled properly. Then they are forged either on upsetters, on bulldozers, or on special shell-forging machines, on pierce-and-draw presses, or by piercing and cross rolling, or else in one-shot forging presses. Even steam hammers have been successfully adapted for shell forging.

The multiplicity of forging processes is such that a forge superintendent who contemplates the production of shell blanks may well wonder which process he should adopt. In many cases, the answer to his problem is not easy. The size of the shell makes a difference; equipment already installed in the shop is often a determining factor; the probable duration of a war or defense project is an unforeseeable factor, and so are the taxing and renegotiating policies of the Government. In a long war, with manpower shortage, the purchase of most modern, laborsaving equipment is indicated, whereas adaptation of equipment already in the shop is indicated, if the war promises to be of short duration. The decision may call for a trip to the fortune teller.

A look at the right-hand side of Fig. 1 will be of assistance in the study of shell forging. It illustrates a typical shell forging for the U. S. Army. The lines in the metal are indicative of the flow of metal during the forging process. The question immediately arises: Can this forging be produced from a square slug with rounded corners, in one single operation? The answer is, "Under certain conditions, Yes." It is impossible to produce this final shape by ramming a punch into a stationary square slug in a die, because the backflow of the metal along the long cone of the piercing punch and in the die causes enormous friction.

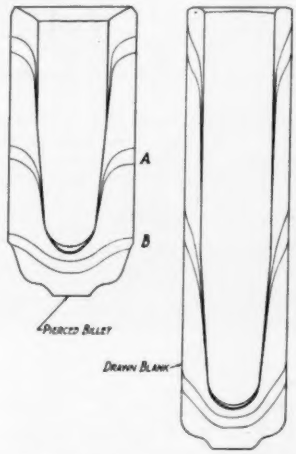


FIG. 1 FLOW OF STEEL IN PIERCING AND DRAWING SHOWN BY INSERTS

The author developed the theory of punch pressure, a paper[2] describing the process being presented in 1944. If it were attempted to pierce to the final shape against a fixed abutment, the compressive stress in the punch would lie somewhere between 85,000 and 100,000 psi. Any long slender punch subjected to so high a stress buckles; and if it did not buckle, wear would be extremely rapid.

If the abutment is not fixed, the final shape can, under certain conditions, be produced in a "one-shot press." In that press, the bottom or abutment yields when a predetermined but adjustable force is exerted against it. The progress of the deformation is illustrated in Fig. 2. It must be realized that the successive stages were obtained with different blanks and that the press was stopped at different depths of penetration. Tests made in the forging of British shells showed that the stress in the punch was always less than 50,000 psi.

During World War II a number of one-shot presses were in operation in Canada, whereas only one almost-one-shot press was in operation in the United States (in Wisconsin). The difference in the numbers may have been caused by the difference in the shape of the cavity and the thickness of the bottom in British shells and in Usayan (American) shells. The British shells have a short taper and a thick bottom, both

[1] Copies of the two reports may be obtained from the Library of Congress by ordering PB-3128-ASME Shell Forging 1943; microfilms \$3.50, photostats \$22. PB-16124-ASME Shell Forging, Large Caliber, 1945; microfilms \$1.50, photostats \$10.

Contributed by the Metals Engineering Division and presented at the Fall Meeting, Minneapolis, Minn., Sept. 26-28, 1951, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[2] "Forces Acting in the Piercing of Cylinders," by W. Trinks, ASME pamphlet "Forging of Steel Shells," Trans. ASME, vol. 66, 1944, pp. 11-14.

of which facts result in forces which are smaller than those which are caused by a thin bottom and a cavity with a long slender cone. The many pipes and valves of the one-shot press give the Canadian presses the appearance of complication, but the Wisconsin press was even more complicated, possibly because it forged U. S. Army shells. In spite of the complication, it was not a true one-shot press, because an auxiliary press was needed for obtaining correct thickness and shape of the shell's bottom. These facts will probably interfere with adopting the one-shot press in the United States. Furthermore, the one-shot press has a very long stroke, is very tall, and is most decidedly wartime equipment for which no peacetime application can be found.

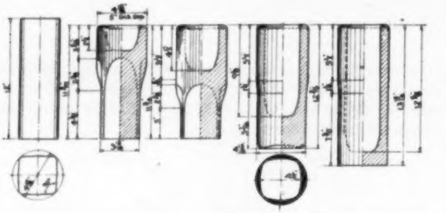

FIG. 2 STAGES IN ONE-SHOT FORGING, CANADIAN METHOD

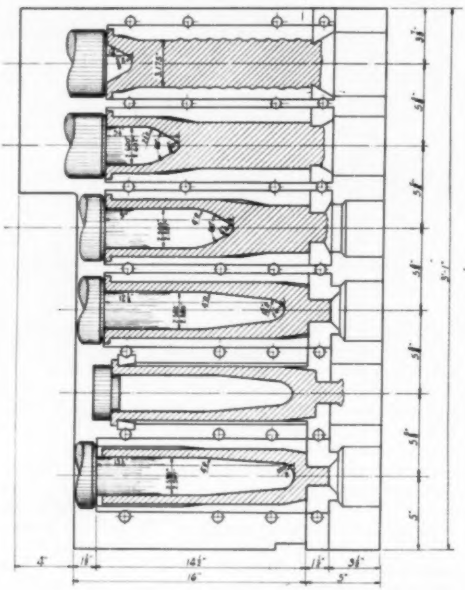

FIG. 3 TOOLS FOR MAKING 90-MM UPSETTER FORGINGS

UPSETTING PROCESS FORGING SHELLS

During the last war, shells up to 105 mm diam were successfully forged in upsetters. An upsetter is a widely used forging machine that received its name from upsetting a bar for the purpose of forging a head on it. After the foot treadle has been stepped upon, the crankshaft makes one complete revolution, and then stops. In contrast to the one-shot press, the upsetter method requires five to six shots for completing a shell forging. These progressive shots are illustrated in Fig. 3. While the illustration shows metal in all dies, there actually is metal in only one die at a time. The dies lie in a vertical plane. In each lower die the cavity is progressively deepened.

As previously mentioned, shells up to 105 mm diameter have been successfully forged on upsetters of sufficient size and rigidity. Shells of 155 mm diameter were also forged on upsetters, but the process proved to be economically unsound, because no muscular operator could be located who was $7^1/_2$ feet tall and weighed 325 pounds.

Any forge shop with upsetters of the correct size can quickly be converted to shell forging for sizes from 75 to 105 mm.

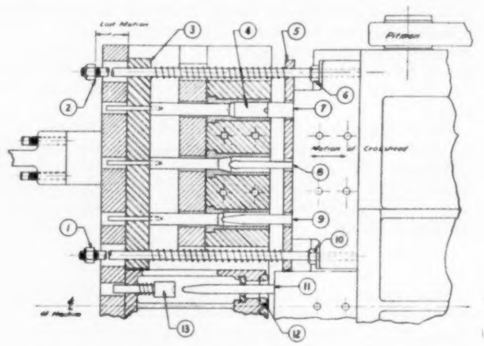

FIG. 4 SECTION THROUGH DIE BLOCK OF BULLDOZER

If a forge shop is equipped with extra-large upsetters and there exists an insistent demand for immediate delivery of 155-mm shells, upsetters may be pressed into service, but the forging should be transferred to other machines just as soon as they are available.

ADAPTING THE BULLDOZER

Another machine which can be converted quickly from peacetime use to shell forging is the bulldozer. This machine has a broad or wide crosshead which is slowly reciprocated on horizontal guides by two strong pitmen (connecting rods). The manner in which shells are forged in a bulldozer is illustrated in Fig. 4 which is a horizontal cross section through the center of the dies. The billet in die 4 is squashed and center-punched by plunger 7. It is successively pierced by punches 8 and 9 and is drawn by mandrel 11 through ring die 12. The operators stand on an elevated platform and by means of tongs swing the red-hot blanks from one die to the next one. Difference in expansion between the hot die block and the cold punch-carrying crosshead must be equalized by artificial heating.

The number of shell forgings which are produced by a bulldozer can be doubled if the blanks are partly forged on the bulldozer and are finish-forged in a draw-bench or in a cross-rolling mill. Both processes of finish-forging will be described.

The bulldozer has been adapted to a very ingenious method of shell forging which is known as the French extrusion process and which is illustrated in Fig. 5. Billet 5 is inserted from above and is pushed by punch 2 into die 6, where it is partly pierced. When face 1 strikes face 3, the abutment remains in

place, but die 6 moves to the right, and the displaced shell material flows back without contacting either punch or die. In that manner much friction is eliminated. In practice, a second mild piercing stroke is made; the third stroke elongates the shell to final shape by drawing it through a ring die. The French extrusion process of shell forging deserves to be more widely used.

### THE PIERCE-AND-DRAW PROCESS

By far the greatest number of shells have in the past been forged by the pierce-and-draw process By this process a short thick-walled blank is produced in the first step. That blank is then elongated into a thin-walled shell either in a drawbench or in a cross-rolling mill. Fig 1 shows at the left a typical pierced blank, and at the right the previously mentioned

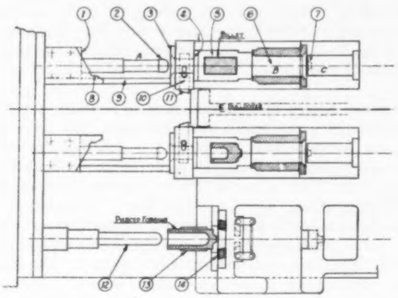

FIG. 5 PLAN VIEW OF BULLDOZER TOOLS FOR FRENCH EXTRUSION METHOD

elongated blank which is ready for rough machining The piercing press is usually operated by hydraulic pressure. Force application by hydraulic pressure is its own safety device. If the force becomes excessively great, the press stops. In contradistinction, forging machines which are operated by electric motors must have an element which yields whenever the load becomes excessive. In one plant in Mississippi a piercing press was operated by an electric motor through block-and-tackle cables. A heavy overload pulled the motor off its foundation. A hydraulic press is illustrated in Fig. 6. This particular press was so speedy that two drawbenches were required to keep up with it. It should be mentioned here that billets can be pierced from the top down or from the bottom up. In bottom piercing, the scale drops out of the die by gravity. In top piercing, the scale is blown out by steam or compressed air.

As previously mentioned, the short thick-walled blank which comes from the piercing press is usually finish-forged in a draw-bench. This piece of equipment consists of a number of rings (of gradually decreasing diameter) through which the shell blank is pushed by a mandrel. In the making of seamless tubes the same machine is called a push-bench. The mandrel pushes, and the shell is drawn. Hence the double name "draw-bench" and "push-bench." Reduction in diameter and increase in length of shell are illustrated in Fig. 7. The shell passed through three draw rings. Displacement of material caused by the ring dies is indicated by different cross-hatching. In some forges, ring dies have been replaced by roller dies. Roller dies last longer than ring dies because wear is distributed over a larger area. Roller dies must be carefully designed if fins on the shell are to be avoided.

In Fig. 8 the first pass is shown, and also the second pass.

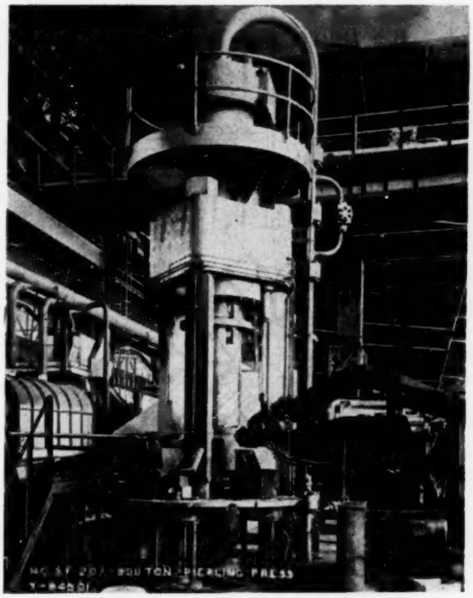

FIG. 6 HYDRAULIC PIERCE-AND-DRAW PRESS

The final pass is circular. In two forges, the first passes were of the roller type and the last pass was of the ring type, for the purpose of pushing the fins back in again. Roller dies require more power than ring dies because the contact surface is colder

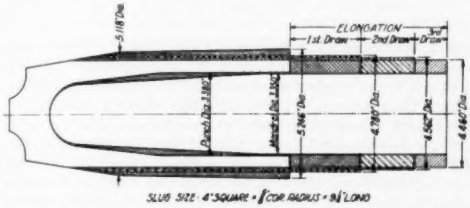


FIG. 7 EXAMPLE OF PIERCE-AND-DRAW PRACTICE FOR 105-MM SHELL

than that of ring dies. The cold surface chills the shell blank and increases its resistance to deformation.

It may be remarked that the pierce-and-draw process is applicable to the forging of shells of any size, from 75-mm up to 16-in. naval shells. Although the process is the same, handling apparatus is vastly different for small and for large shells.

### THE CROSS-ROLLING MILLS

In a few forges, cross-rolling mills were used instead of drawbenches. Three cross rolls or skew rolls are evenly spaced around the axis of the mandrel and shell blank. A rolling mill of this type is called an "Assel" mill, after its inventor. Fig. 9 is a section through a partly elongated shell blank and through one of the three rolls. The drawing is diagrammatic

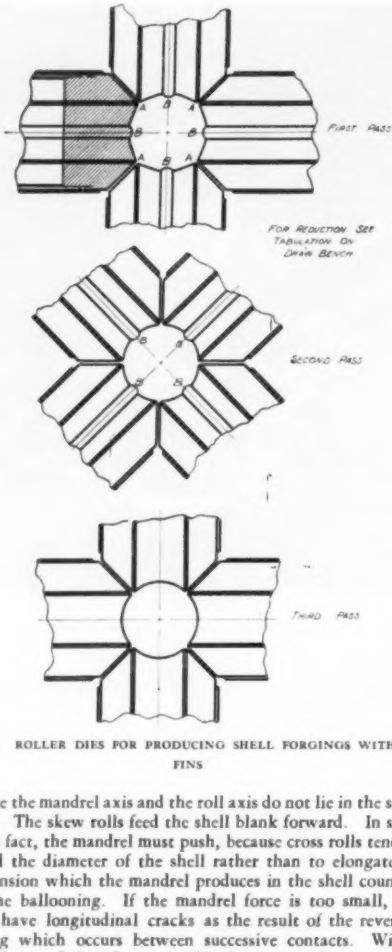


FIG. 8 ROLLER DIES FOR PRODUCING SHELL FORGINGS WITHOUT FINS

because the mandrel axis and the roll axis do not lie in the same plane. The skew rolls feed the shell blank forward. In spite of this fact, the mandrel must push, because cross rolls tend to expand the diameter of the shell rather than to elongate it. The tension which the mandrel produces in the shell counteracts the ballooning. If the mandrel force is too small, the shells have longitudinal cracks as the result of the reversed bending which occurs between successive contacts. Witter added the mandrel to the Assel mill; the process is known as the Witter process. The Assel-Witter mill has, disparagingly, been called "a very expensive draw-bench."

The pierce-and-draw process requires equipment for which there is practically no use in the production of civilian goods. The machinery can be converted for the production of seamless tubes by the push-bench method. However, that method has been found to be too expensive in comparison with other methods of making seamless tubes.

### THE NOSING OPERATION

The forged shell blanks are inspected for concentricity and are rough-turned. Then they are nosed. The nosing operation is a forging process. Since the mouths of U. S. Army shells of all sizes have the same diameter, the unit deformation in nosing is very small for 75-mm shells and very great for 240-mm shells. The consequence is that small shells can be nosed cold, whereas large shells must be nosed hot. Fig. 10 shows a large shell about to be nosed by the die which is outlined above the shell. Success in the correct nosing of large shells requires either much calculation work or else considerable experimenting. Contour of rough-turned shell, temperature distribution in the heated end of the shell, temperature and lubrication of die, and speed of descent of die, all enter into the problem. If a self-contained, slow-motion press is used the problem becomes quite big, because with such a press two heatings and two nosing strokes are required. Shells of 155 mm diameter have been nosed either cold or hot. Hot nosing is preferred, if the elongating operation, for instance, cross rolling, has a tendency to produce cracks.

### OPERATIONS PRECEDING FORGING

Several operations are necessary before hot forging can begin. Mill-length billets are divided into forging billets or slugs by various methods, such as sawing, shearing, burning, and breaking. Breaking (after nicking by flame or electric arc) is recommended for that section which, later on, forms the base of the shell, because the fracture permits inspection for soundness of material. The other methods cover up the defects.

Billets are heated in any furnace that produces a uniform temperature in a reasonable time and with low labor cost. If heating is nonuniform, the punch is deflected toward the hotter side, and the shell forging becomes scrap. Nonuniform cooling of the billet on the way from the furnace to the press has a similar effect. During World War II, pusher-type continuous furnaces and furnaces with rotating hearths were widely used. Small billets were usually heated in slot-type furnaces. In all of these furnaces much scale was formed. For a given composition of steel, the thickness of the scale is a function of time and of surface temperature of the billet. Since scale wears dies and punches, good practice requires its removal. The best method for removing scale consists of directing properly spaced sprays of high-pressure water against the billet for a fraction of a second. A pressure of 2500 psi removes every bit of scale.

Billets for shells up to and including 105 mm diam were successfully heated by induction. This type of heating is so rapid that only a negligible amount of scale is formed on small billets. Furthermore, the rapid heating cracks off the original mill scale. Induction heating is not rapid enough to prevent the formation of objectionable scale on larger billets. And difficulties arose in handling large billets into and out of the induction heaters.

Since the end of the last war, high-head heating by extremely hot products of combustion has been introduced. Gas is burned instantly, whereby the ideal or adiabatic flame temperature is almost reached. Almost the whole surface of the entering cold billet is exposed to this intense heat, which is kept up until the billet is ready to be soaked. Experimental tests on this method of heating were made by the Selas Corporation of America (Philadelphia) during the last war. Since then, that company, the R. S. Products Corporation (Philadelphia), and the Surface Combustion Corporation (Toledo) have reduced high-head heating to practice.

Fig. 11 is a section through a modern, continuous billet-heating furnace, which embodies the high-head principle. It was built by the Surface Combustion Corporation. The billets rest V-shaped on thin, water-cooled skid pipes and are pushed along them. After having been heated to a temperature which somewhat exceeds the desired final temperature, each billet enters a soaking zone, in which the desired final temperature is maintained. In that zone the billets rest in chromite grooves. The furnace is fired by 20 tangential burners on each side. They produce "rotaflames." Each of the sections of 10 burners is independently controlled. The arrangement of

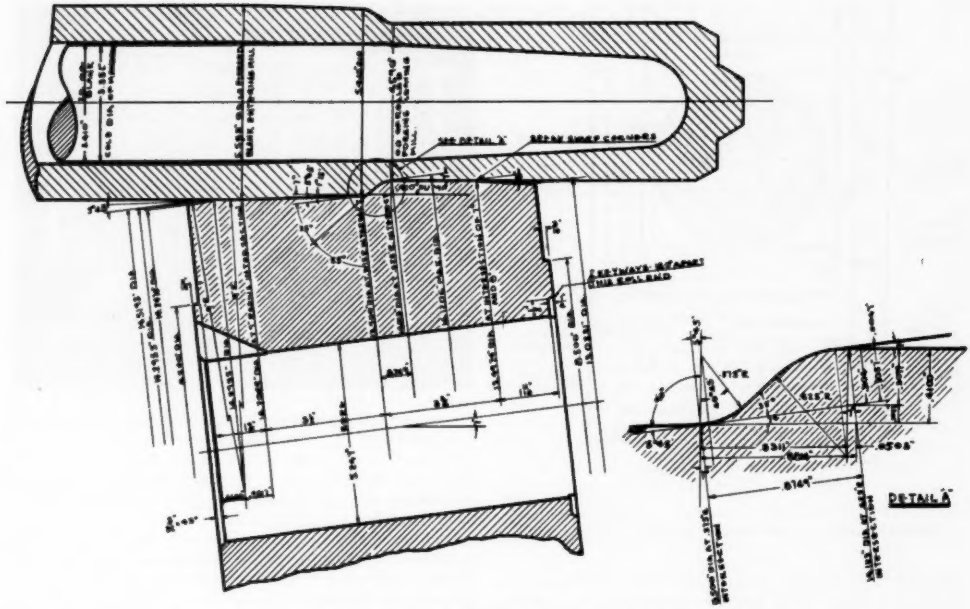

FIG. 9 ROLL AND MANDREL FOR ELONGATING SHELL BLANK BY CROSS ROLLING

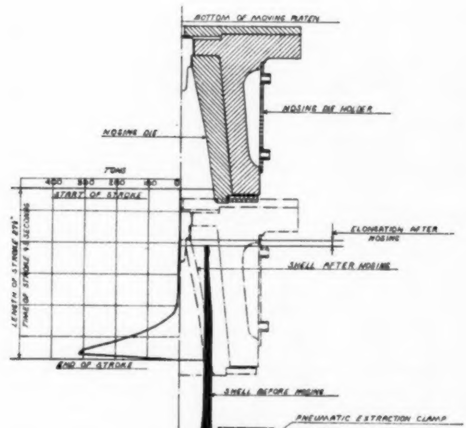

FIG. 10 LARGE SHELL ABOUT TO BE NOSED BY DIE OUTLINED ABOVE SHELL

burners in a similar furnace is illustrated in Fig. 12. In this latter furnace, steel billets, 4 in. square, have been heated in 12.4 min to a core temperature of 2250 F. Thickness of scale ranged between 0.003 and 0.005 in. In case of a press delay, such as die-grinding or replacing a punch or changing a ring die, the dampers which are visible on top of the furnace, are closed, and a mixture of two parts of air to one part of natural gas is introduced into the furnace. Scaling during press delays is greatly reduced by this method.

In case of long interruptions, some billets are pushed out. Upon restarting, the burners at the discharge end are lighted first, and press work can quickly be resumed. It is quite possible that high-head heating will replace older methods, because the scaling loss is almost eliminated and because the furnaces are small in comparison with older furnaces. However, the fuel consumption per unit weight of heated material is high.

### COLD-FORGING PROCESS

An innovation in shell forging is cold-forging, or cold extrusion, as it is sometimes called.[3] The process was originated in Germany during the last war and is now practiced by the Mullins Manufacturing Company of Salem and Warren, Ohio. The company was legally advised not to release any information beyond that published,[3] at least not before the end of 1951. The order of operations is given in Fig. 13 and it is shown that eight operations are needed to produce a nosed shell, compared to three operations in the pierce-and-draw process. However, while the number of forging operations is increased, rough-turning and almost all of finish-turning are eliminated.

Obviously, cold-forging requires a shell steel that can un-

[3] Described in *Iron Age*, Oct. 19, 1950.

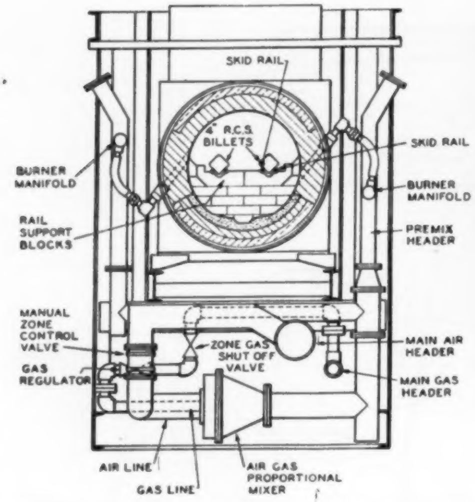


FIG. 11 SECTION THROUGH A MODERN, CONTINUOUS, BILLET-HEATING FURNACE, EMBODYING THE HIGH-HEAD PRINCIPLE

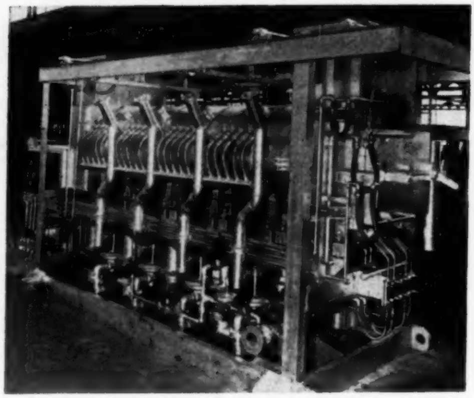

FIG. 12 ARRANGEMENT OF BURNERS IN A CONTINUOUS BILLET-HEATING FURNACE

dergo severe deformation without cracking and yet, in the finished product, has the properties required in a high-explosive shell. The steel from which shells are now being cold-forged has less carbon, manganese, silicon, phosphorus, and sulphur than the steel which serves for hot-forging. The composition of the steel used by Mullins in 1950, is given in the previously cited reference.[3] The steel which will finally be adopted for the cold-forging of shells will probably have a somewhat different composition.

Cold-forged shells are die-finished and are, for that reason, uniformly smooth. Their trajectories are therefore very uniform except for inequalities that may be caused by improperly applied rotating bands. Since machining operations are reduced to a minimum, cold forging requires less steel in the billet than hot forging. Since all rough-turning and most of finish-turning are eliminated, the cold-forging process does

(Continued on page 817)

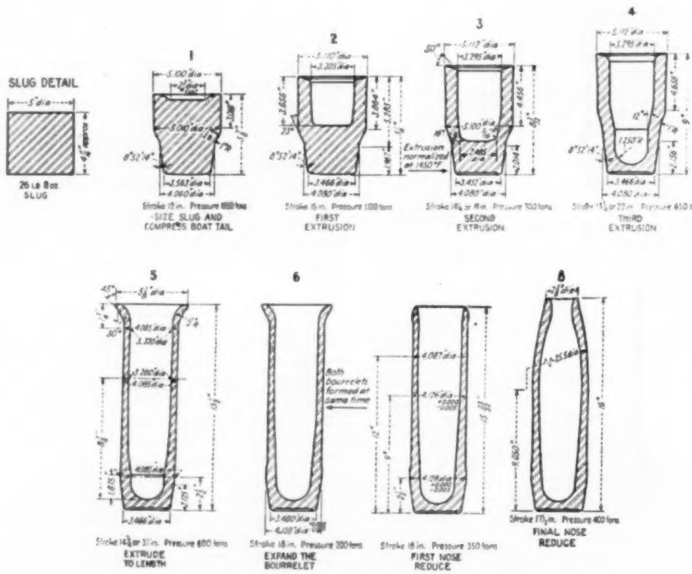


FIG. 13 SEQUENCE OF OPERATIONS IN COLD-EXTRUDING 105-MM SHELLS

# POWER *From* WOOD WASTE

## *Collection, Storage, and Combustion of Kiln-Dried Sawdust, Chips, and Shavings in a Modern Furniture Factory*

By W. H. KUHN,[1] E. A. CARSEY,[2] and D. L. GUSLER[3]

WOOD-products industries offer an ideal field for reclaiming energy from wood waste. Conversion of shavings, chips, and sawdust by combustion in boilers provides a high rate of recoverable energy which is easily converted into power by means of modern generating equipment. It also solves the problem of disposal of waste materials.

Kiln-dried wood waste in the form of shavings and sawdust may amount to 65 per cent of the productive board feet of lumber cut in a typical furniture manufacturing plant. If the plant processes 40,000 board ft in 24 hr, 26,000 board ft would be in the form of combustible scrap; or, at 3 lb per board ft, a total of 78,000 lb in 24 hr.

This recovery potential has justified complete powerhouse installations and has more than warranted expenditures of rather sizable sums.

Increased production of wood products through installation of high-cycle woodworking equipment has added further economic significance to this recovery potential by increasing the amount of wood waste.

Properly engineered installations have resulted in energy recovery amounting to 8000 to 8500 Btu per lb of wood waste, or somewhat more than one half the heat value of the best-grade coal.

An installation resolves into the following basic components:

1. The collection and transport system to carry the waste from each of the individual working machines to a storage bin.

2. The bin, its related conveyers, and controlled feeding arrangements.

3. The boiler and generating equipment for conversion into steam and electric power.

The several components of any installation are interdependent, and all must be considered for the proper evaluation of a complete project. It is necessary to have all components in perfect balance as hazardous conditions will result unless provided for in the initial stage of the design. For example, the centrifugal collector should deposit collected wood waste in the storage bin without the transmission of positive static pressure which otherwise would encourage packing and arching of the materials in the bin. The bin itself must be of such design as to minimize arching, and of such physical proportions adequately to store collected materials. The boiler and related accessories must be engineered to burn the waste materials properly.

The complete project to be considered[4] covered three identical powerhouses, with all construction planned and programmed so as not to interfere with plant production of the individual plant involved.

#### COLLECTING SYSTEMS

Each of the three shavings and sawdust-collecting systems is designed to produce 200,000 cfm of air. This volume of air is handled at an average static pressure of 8 in. of water, thus resulting in exhauster power requirements of 422 shp at 60 per cent fan static efficiency. Hogged refuse is handled by separate extra-heavy fans, with somewhat higher pipe velocity than the regular system. A velocity of 4000 fpm is maintained in all mains and branches, with actual hood connections increased to 4500 fpm.

Heavy-gage galvanized-steel piping, one-piece triple-ribbed elbows, and laminar-type fittings are used throughout. Long-cone centrifugal collectors arranged in batteries, equipped with adjustable governors, wrap-around inlets, and central vertical exhaust stack, are provided to receive the collected refuse and separate this material from the conveying air.

#### STORAGE BIN

A horizontal bin with its related conveyers is used for storage of the wood waste and for subsequent feeding to the boilers.

Fig. 1 shows in detail the layout of the horizontal-bin system as it has been developed for storage and feeding of sawdust, chips, and shavings to refuse-burning boilers. The bin is designed so that it can be extended readily and adapted to the feeding of wood waste to more than two boilers, similar to a suspension bunker in a coal-burning powerhouse.

The bin with its live bottom is the latest development in sawdust handling and storage facilities. It eliminates the problem of arching and reduces almost completely the hazard of fire due to flash back originating in the stoker hoppers.

#### CONVEYERS

A unique system of handling wood waste is developed around three sets of drag-type conveyers, two of which run at a constant speed in one direction, and the third, or "run-around" conveyer which runs in an opposite direction at a variable speed. These conveyers, in conjunction with a recirculating-type blower system, maintain constant agitation of the sawdust and shavings. This agitation is responsible for maintaining the desirable condition of uniform material density throughout the bin.

Two collectors are mounted at one end of the storage bin. The "incoming" collector is the receiving unit for all sawdust, chips, and shavings from the factory. The other, or "return" collector is the receiving unit for all material from the recirculating system.

The design of the individual flights and the variable speed of the run-around conveyer, located in the center of the bin, produces a shearing of the wood waste approximately 2 in. above the top of the flight. The material is moved along the

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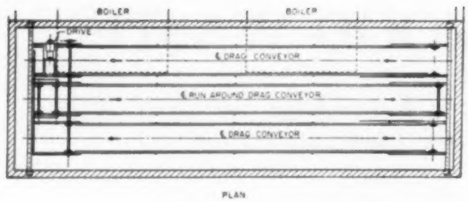
[1] The Fairfield Engineering Company, Marion, Ohio.
[2] The Kirk and Blum Manufacturing Company, Cincinnati, Ohio.
[3] Bassett Furniture Industries, Bassett, Va.
[4] The installation is that of Bassett Furniture Industries, Inc., Martinsville, Va., and Bassett, Va.
Contributed by the Fuels Division and presented at the Spring Meeting, Atlanta, Ga., April 2–5, 1951, of The American Society of Mechanical Engineers.



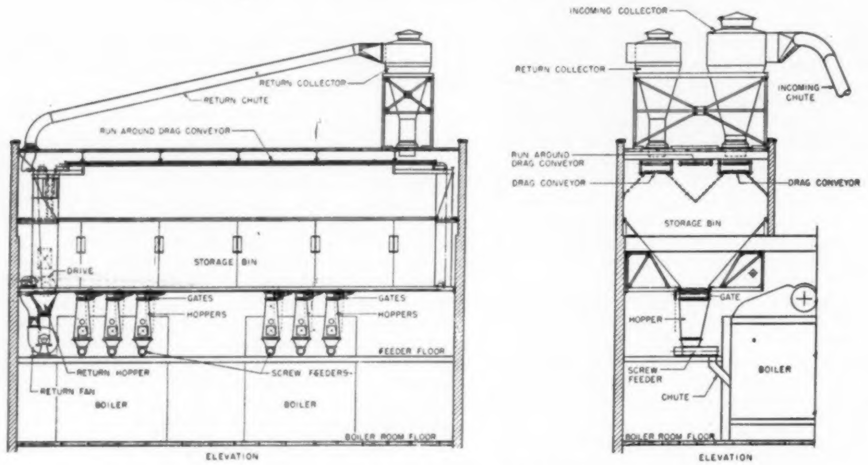




FIG. 1 ARRANGEMENT OF HORIZONTAL BIN SYSTEM

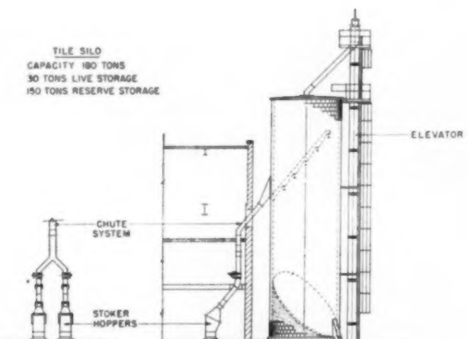



FIG. 2 LAYOUT OF COAL-HANDLING EQUIPMENT

bottom trough and is discharged by gravitty into any one of six surge hoppers. The speed of the run-around conveyer is always selected to deliver more material than is being burned in the boilers. This is done so that the excess can be returned by the recirculating blower system back into the top of the bin. Complete agitation is thus obtained.

Each boiler has a set of three screw feeders for controlling the feed of wood waste. One set operates independently of the other set, making it possible to run the plant on only one boiler at a time.

A pressure-type boiler regulator is provided for each boiler. Operating through the pressure regulator and mechanical linkage to a common jackshaft, the speeds of each set of screw feeders are varied to satisfy load requirements.

### COAL-HANDLING SYSTEM

This powerhouse was designed to operate on wood waste as a primary fuel with coal as a stand-by fuel. Fig. 2 shows in detail the layout of the coal-handling equipment. It included a track hopper, flight feeder, bucket elevator, vitrified-tile silo, and chute system to "pneumatic-type" spreader stokers.

Coal is unloaded from railroad cars and conveyed at a rate of 20 tons per hr to a 180-ton tile silo. The silo has a 30-ton live-storage compartment and 150-ton reserve-storage compartment. Coal is reclaimed to the live-storage compartment by the coal elevator and at the same time this recirculation helps to prevent spontaneous combustion. The firing system is automatically controlled and when the supply of the primary fuel has diminished to an insufficient quantity to sustain load requirements, the coal is cut in.

### BOILERS

Two boilers, each generating 20,000 lb of steam per hr, were used to burn wood waste and produce steam at gage pressure of 200 psi. Fig. 3 is a cross section of the selected boiler. It has a radiant front wall, and waterside and back walls. The furnace width is 14 ft 6 in., stoker length 9 ft $8^5/_{16}$ in., stoker width 13 ft 6 in., providing a combustion chamber of 2770 cu ft. Ample volume is thus provided for suspension burning of wood waste much in the same manner as pulverized coal. Sawdust, shavings, and sander dust are all burned in suspension, while hogged waste is burned almost instantaneously as it drops onto the grates.

It will be observed that the boiler is equipped with a steam drum 48 in. diam and a mud drum 36 in. diam. Total heating area is 6257 sq ft, made up of 5256 sq ft in the main tube bank,

463 sq ft in the side waterwalls, 296 sq ft in the bridge wall, and 107 sq ft in the steam drums.

The screw-feeder discharge chutes terminate immediately above the high-velocity low-volume air jet, energized by a pressure blower. These airjets play an important part in the furnace operation, in that they establish both necessary turbulence and area distribution not otherwise accomplished.

Since suspension-burning is encouraged, jet air volume must be balanced to provide it without impingement or excess air

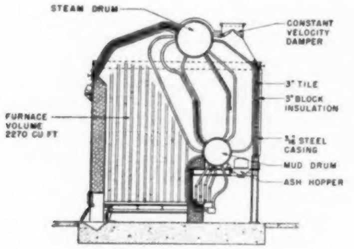



FIG. 3 TYPE OF WATER-TUBE BOILER USED

to material weight ratio, at all times maintaining velocity greater than flame propagation.

Much doubt was expressed originally as to the feasibility of burning wood waste in a waterwall boiler due in part to the widespread use of the radiant-wall type. In the case of two previous installations the radiant-wall furnace and their operation have been excellent from the standpoint of providing stable and efficient combustion. However, intense heat resulting from suspension burning causes many refractory problems, particularly the bridge wall and adjoining side wall. Several types of plastic refractory and firebrick have been used without solving for an adequate period of time the problem of furnace maintenance. Plastic refractory will generally crack and flake off, also erode wherever there is flame impingment. Besides the intense heat, intermittent operation of the boilers wherein shutdowns occur during the noon lunch hour, at night, and week ends, effect undesirable expansion and contraction of the refractory. The obvious solution is the waterwall furnace.

It was found necessary to keep the grates covered at all times to provide even distribution of air entering the furnace. Gravel was used to cover the grates and was very effective. There has been no tendency of the gravel to fuse together.

No difficulty has been experienced in maintaining ignition in the waterwall boiler. It is found necessary, however, to reignite should the boiler become inoperative more than 1 min. Combustion takes place before the gases reach the first tube bank; therefore it has been possible to carry a $CO_2$ count of 14 per cent to 15 per cent continuously with little more than a slight haze being observed at the stack outlet. It is gratifying to report that even at 200 per cent of boiler rating, flue-gas temperatures did not exceed 700 F. All boilers have been in operation over a year and it has not been necessary to clean or "deslag" them.

The boilers have a fly-ash reinjection system installed at the last pass. Fly ash is controlled effectively in this manner providing the $CO_2$ count is less than 15 per cent.

## STEAM ENGINES

In the design stages, consideration was given to the following power-generating arrangements:

1 Two bleeder-type turbines, operating condensing, connected to two 1250-kva generators.

2 One engine operating at 200 psi and exhausting at 10 psi to a turbine, operating condensing. With this proposed arrangement, the turbine would use only the exhaust steam not actually required for processing.

3 One bleeder turbine, operating condensing, to a 2500-kva generator.

4 Two multicylinder uniflow engines directly connected to two 1250-kva generators; the engines to be operated from steam at 200 psi and exhaust at 10 psi.

Since the factory operates an 8-hr day with load variations from 150 to 1500 kw, the latter arrangement was selected because the engine water rate is constant over a wide variation in load. If the furniture factory was operated for 24 hours a day, the turbine would have been the more practical arrangement, particularly if the surplus power could be sold.

Results of the installation have been gratifying, as illustrated in Figs. 4 and 5. Fig. 4 was prepared to show relative net gain in pounds of steam generated between the old and new installations. A net gain of 186,000 lb of steam per day was achieved on a basis of 40,000 board ft of lumber cut. This resulted in being able to produce 6.7 lb of steam for every pound of wood waste. Fig. 5 shows the relative net gain in kilowatt-hours over a 21-day-month operation, and amounted to 145,500 kwhr on the same basis of 40,000 board ft of lumber cut.

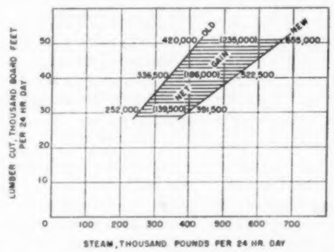



FIG. 4 RELATIVE NET GAIN IN POUNDS OF STEAM GENERATED BETWEEN OLD AND NEW SYSTEMS

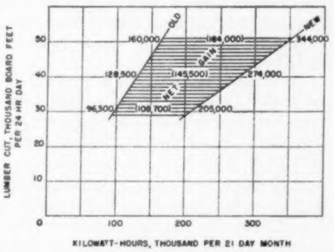



FIG. 5 RELATIVE NET GAIN IN KILOWATT-HOURS OVER 21-DAY MONTH OPERATION

The results obtained from these three installations prove without a doubt that "power from wood waste" cannot be overlooked by the economical-minded progressive manufacturer.

## ACKNOWLEDGMENT

The authors are indebted to Mr. W. M. Bassett, President of Bassett Furniture Industries, Inc., in permitting publication of the material contained in this paper.

# SMOKE REGULATION IS BIG BUSINESS

By HARRY C. BALLMAN

SMOKE REGULATION ENGINEER, COLUMBUS, OHIO. MEMBER ASME

WHILE most engineers have had some business experience, few have had occasion to participate in the administration of a city ordinance. In order to focus attention on the value of a smoke-regulation ordinance from the point of view of business, the following comparison is made: In the case of an ordinance it has been my experience that:

(*a*) All interested parties work for an ordinance controlling smoke or air pollution.

(*b*) When the ordinance is completed and passed, all interested parties brush their hands in the air and say, "This is a job well done."

(*c*) Because of this attitude most folks come to believe that, after the ordinance is written, smoke is controlled, because "It is against the law to make smoke."

Let me compare this to the business formula:

(*a*) An individual works for a charter for a corporation, or works to establish the proper legal papers for a partnership, or works hard to establish a lease on a piece of property if he owns the business individually.

(*b*) This effort on his part of legalizing the business and placing it in operation is similar to the establishment of a city ordinance. Therefore, he can now relax and consider that the job is done.

(*c*) Because the business is properly incorporated, or the partnership papers are properly written, or because the proper leases have been obtained, as business owners or management, the individuals can now brush their hands in the air and say, "Our profit is made."

There certainly would be no disagreement in this last case, realizing full well that the job of profit-making begins only after the business has been legalized. So it is true with any city activity. The job begins only after the ordinance is written. I believe one of our greatest fallacies today, particularly in smoke regulation, is in the individual's inability to understand that all government activity—at city, state, or federal levels—is "big business" and, frankly, should be operated as big business. The only difference I can see between a smoke-regulation activity and big business lies in the fact that, in smoke regulation, the stockholders or citizens, and the customers or citizens are the same people, whereas in business the stockholders and the customers are usually quite different people.

Another interesting aspect of city government lies in the fact that we often are not willing to pay for the services we need or require. Any businessman would be perfectly willing to sign a contract for a specified required service and pay a reasonable sum of money for this service, and feel that he had negotiated the matter properly. In city government, it is often found that the demand for services comes from the same people who do not wish to pay for the services. In smoke regulation or air-pollution control the city can no more offer something for nothing than can good business. Each citizen can have just as much smoke regulation or air-pollution control as he wants and is willing to pay for, and absolutely no more.

This program encompasses every activity, industrywise, commercialwise and householdwise. No one man, whether he be mayor or smoke engineer, can give or foist upon a city a smoke-regulation program. The city will have just as much smoke or air-pollution control as the people want, and absolutely no more than they want. When we are dealing with municipal plants, railroads, and large industries, it is only the force of the people of a community which makes it possible to accomplish this basic purpose.

If a city desires a smoke-regulation program, it is necessary to set up and finance the organization. Get qualified personnel for administrators in the same manner that one would set up a business for a profitable enterprise. There are profits to be had in smoke regulation or air-pollution control just as there are in any other activity. If the smoke-regulation program is not planned to be a profitable institution to a city, then it should not be established.

## SCOPE OF THE PROBLEM

To express this more forcibly, in any city activity the scope of the problem is set. It must be based upon the city-wide problem.

In other words:

(*a*) A fire department cannot be organized which would put out half a fire.

(*b*) A garbage-collection service cannot be established which would gather one fourth of the garbage of the community.

(*c*) Zoning for one third of a city is not feasible.

Each problem of the city must be considered on the basis of the whole city. Consequently, with smoke regulation, an inadequate or partial program is not practicable. The establishment of a full operating division must be undertaken. Certainly there is no desire to hurt a few without the accomplishment which can accrue to the many. May I point out that tampering with smoke-regulation programs is a very dangerous matter. Temporizing and meddling with smoke-control programs will hurt many in a city without the accomplishment of the good results which can be expected.

Allow me to refer to the City of Columbus and quote one year's activity there:

3000 New installation inspections
29000 Locomotive operations
3500 Old-plant inspections
1078 Stationary violations
Also, special jobs—visibility, weather, fly-ash tests, etc.

This adds up to 300 cleaned-up sources or, in terms of money, this activity of nuisance control led directly to the expenditure of approximately $7^1/_2$ million dollars by all types of industries,

An address, slightly abridged, presented at a meeting in Peoria, Ill., May 24, 1951, before the Peoria Association of Commerce Smoke Abatement Committee and the Central Illinois Section of The American Society of Mechanical Engineers.

commercial establishments, and residences during that year. I believe that most people would say that a $7^1/_2$-million dollar business is "big business!"

###### LAW ENFORCEMENT

This brings us to a point of law enforcement. Any smoke-regulation or air-pollution program which is directed against a few should not be tolerated and probably will be found illegal. Any regulation program must be directed against all parties whether industrial, commercial, or domestic. This brings us to another factor of placing a smoke-regulation or air-pollution control program on the proper basis. In the past, all too many programs have failed because of the wolf-cry of over-emphasizing affected health based upon air-pollution problems. Smoke as such has never been ascertained by the medical profession to affect a man's health directly and adversely. It is, however, a basic nuisance and most state legislatures have allowed a city to control nuisances originating within its borders.

Smoke-regulation and air-pollution programs in these later years are approaching their problems on the realistic basis of regulating a nuisance instead of starting from the early false premise of a health problem. Smoke control is just one part of the total air-pollution problem; and even though the first efforts are made toward smoke and fly-ash control because they are visible to the average citizen, yet I advocate that the program be so set up that eventually it will encompass all of air pollution.

Ours is probably the greatest sales program that anyone has ever considered. Anyone who is in the sales profession probably thinks in terms of a percentage of the total market that he can sell. How would such a salesman like to place himself in the position of administrator who had to sell 100 per cent of his market? That is our problem. Owing to the fact that we have to sell 100 per cent of the market, we have to keep ourselves in a very strong selling position. This calls for a strong incentive not only to the seller but to the buyer of our program, which we have in the form of disciplinary action or penalties. We have to consider, as does the good sales program, several things which we like to call market conditions:

(*a*) Availability of corrective equipment and materials have to be considered. Shortages in any field of activity such as we are encountering have to be considered. Certainly if corrective material or equipment is not available, no matter how strong our enforcement, nothing will be accomplished.

(*b*) What is the proper approach to each problem which will enable the party who is responsible for a source of nuisance to acquiesce to corrective measures without the full force of such things as court action? How shall we sell?

(*c*) What are the credit restrictions on each company? In other words, can the company afford those basic responsibilities to a community or does it need a little time to assume its financial obligations which would be involved in corrective measures?

(*d*) What are the obligations of a particular nuisance source to the community as a whole, and how do these evaluate in returns, both to the community and to the individual source of nuisance?

We have found that when these four major points (and occasionally other points) are determined and placed in such a manner before the management of a plant which is a source of nuisance, they not only appreciate the strength of our position, but are willing to go ahead on their own without approaching the enforcement stage. In many cases, we have found corporation counsel to be our greatest asset when they are aware of our position in relation to the individual corporation which they represent. In many cases corporate counsel together with top management have taken issue with plant management for not assuming their responsibilities at an earlier date.

###### BASIC STUDIES NECESSARY

As with other products, we find that smoke-regulation and air-pollution control programs have certain basic concepts which can be applied from program to program. May I, however, point out that programs cannot be brought in toto from one city to another, but consideration must be based upon local conditions. It must be realized that a survey is necessary before setting up a sales or engineering approach to a problem. This survey should also be required of every city. There are basically two factors to be considered:

1 The dispersal rate of the city.

2 The emission rate from the various nuisances within the city.

The emission rate is something which can be reduced; but the dispersal rate, which is directly related to the geography of an area and the weather conditions of an area, cannot be changed. We can do little to control nature. However, if the geographical and weather conditions of an area are evaluated properly, they will set the correlated minimum emission rate for that individual area.

Just one more comparison between big business and a smoke-regulation program:

| Business | Smoke regulation |
|---|---|
| Stockholders | Citizens |
| Board of directors | Citizens committee |
| Executive committee | Advisory and appeals board |
| Administrator | Administrator |

I believe that, in the foregoing, a correlation has been indicated between a city activity such as smoke regulation and big business.

###### CONCLUSION

In conclusion, I would like to place before big business what I believe is a challenge. It may either accept its full responsibility in controlling emissions to the air or, as in the past, eventually it will be confronted with laws whose origin lies in the realm of mass hysteria and clamor for something to be done regardless of realism. As long as smoke-control or air-pollution control programs are sustained by all interested parties, they will be reasonable and there is every reason to believe they will be successful.

Constant vigilance of all parties in sustaining a continuing program is important. It can be done in any American city because it has been done in other American cities. As a citizen today, each individual has this challenge; namely, of continuing in the future realistic control programs which I believe have been so concretely started in recent years.

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THE AIR pollution abatement program in Detroit, Mich., is successful because it is administered on sound engineering principles with no political interference with the conduct of the affairs of the city's Bureau of Smoke Inspection and Abatement and according to the *Review* of the Coal Producers Committee for Smoke Abatement. J. W. Shaw is chief of the Bureau. When newspapers and others were convinced that no abatement of air pollution was possible unless the volatile content of the coal was regulated, Mr. Shaw did not subscribe to this point of view Basing his decision on a thorough study of users' equipment, Mr. Shaw has approved coals with volatile contents as high as 44 per cent

# Accident Prevention and Safety

## A Vital Course in the Engineering Curriculum

By NILES H. BARNARD

PROFESSOR AND CHAIRMAN, DEPARTMENT OF MECHANICAL ENGINEERING, UNIVERSITY OF NEBRASKA, LINCOLN, NEB. MEMBER ASME

COLLEGES of engineering have not given much serious thought to the indoctrination of their students in the study and practice of accident prevention and safety, particularly as it pertains to industry, and generally as it pertains to all walks of life. In all fairness it must be said that there are some engineering schools that have been and are now doing an excellent job in this form of training. Their number is not great enough.

Today, industry is curious to know why the young engineering graduate is not safety-conscious. It soon may become very critical of that lack. We must not wait to be criticized or condemned for this omission.

It is quite possible and practical to teach the engineering student facts about safe practice all through his classroom and laboratory days. Special emphasis can be given in courses in the junior and senior year that will bear much good fruit in minimizing accidents and injuries and in reducing costs which are now found in production due to material damage and manpower loss because of lack of information.

The prevention of accidents is a "must" in all walks of life. If we accept the definition of an accident as follows: "........ an unexpected interruption in the normal course of production" then industry most certainly is interested in the subject. At no time is anything short of a normal course of production desirable. If we substitute the word "life" for "production" in the definition, we will soon find that accident prevention is of prime importance to everyone. I believe we can assert without fear of argument that the prevention of accidents is important everywhere that people are found.

Graduates of engineering colleges find their way into industry immediately upon completion of their college studies. They become involved in production problems of many kinds and, therefore, definitely are connected with the phase of industry referred to as "the normal course of production." Quite often it becomes their responsibility to keep that course of production normal. It seems quite logical, therefore, that one of the important subjects for thought on the part of the embryo engineer is how to prevent accidents. This would seem to be important from a materialistic point of view alone but, when the humanistic aspect is added, then even greater importance will be found.

Safety is a term applied to a practice that is followed in the prevention of accidents. When an individual states that he is interested in safety, he implies that he is interested in the prevention of accidents. Although accidents may occur without injury to persons, one is inclined to associate the three words, accident, safety, and injury, together. Perhaps there is no harm in this association in view of the fact that practice of safety will reduce the number of accidents and minimize or even eliminate personal injuries.

While the engineering graduate may find himself concerned with safety as it pertains to accident prevention and the normal course of production, he will soon find that safety is a term which applies to studies and practice applicable in the home, and on the street, as well as in the factory. Any person who follows unsafe practice is vulnerable to accidents and to injuries wherever he may be. Inasmuch as the young engineer is a person, a human being, he should be and must be interested in safety and its result, accident prevention and its result, a minimum of injuries.

### IN THE NORMAL ENGINEERING CURRICULUM

An average curriculum in almost any branch of engineering will involve courses in handwork, whether they be in shops or in the laboratories, or both. Handwork involves the use of tools, both hand and machine, and the use of equipment that is potentially dangerous. The instructor in the average shop or laboratory is aware of this and generally will spend his first period of the term in explaining safe practice in connection with the use of the equipment. If personal protective equipment is required, he will announce the requirement and see to it that the students are properly provided with it. Unfortunately, in many cases, this first venture in safety instruction becomes the last for that term, and the student soon learns the short cuts to violations of safe practice. If no accident occurs and no injury results, then this careless practice will continue through successive terms. On the other hand, if an injury is experienced by one of the students in this particular laboratory or shop, then there is much wagging of heads and pointing of fingers, and the safety practice is revived for a time.

If every shop or laboratory instructor could realize that "habits are cobwebs soon turned to chains," he would not permit a single student to perform an unsafe act under his supervision.

It may seem a little ridiculous to carry safety subjects throughout all the courses which an engineering student has in his curriculum. Nevertheless, there are many courses other than those labeled engineering in which safety topics could be found. A math teacher can use problems involving the proper position of a ladder when placed against a wall; mechanics teachers can emphasize the tremendous effect of large static forces or increasing dynamic forces on materials which are quite likely to produce failures, not only from the materialistic point of view; science teachers can point out the effects of the forces of nature when handled improperly. It may be a little farfetched to suggest that reading courses have assignments in the field of safety, and yet there would be a great good in that kind of an assignment.

Perhaps it would be effective for the engineering student to concentrate more on the subject of safety than to rely on what he can get from association in other courses in which safety is a part but is incidental.

A three credit hour course in "Safety" is of considerable value in any engineering curriculum. It is not presumed that such a course should be mandatory in all curriculums, but it should be available so that engineering students could enroll

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in it as a place appears in their study outline for an option. It is a very brash instructor who will insist that his particular course be required of all engineering students. Curricula are always so crowded! It seems to this author that the incidental instruction given in accident prevention and in safety, as it pertains to each shop and laboratory, is not enough for an engineering graduate.

By all means, every industrial engineering student should have at least a three credit hour course in safety—perhaps "Industrial Safety" by course name. It takes a tremendous amount of faith to assume that an electrical-engineering student, or a mechanical, chemical, civil, agricultural, or architectural engineering student would need less instruction in accident prevention. Material failures and human failures are not particular concerning the branch of engineering in which they operate.

### SOME RESULTS OF A SAFETY PROGRAM IN A COLLEGE OF ENGINEERING

A safety program in the Department of Mechanical Engineering at the University or Nebraska involves the incidental instruction in safe practice given to freshmen students when they enter their first shop and laboratory course, through the sophomore and junior years in shops and labs, and finally into the senior optional course entitled "Industrial Safety"; which is a three credit hour option course for anyone with senior standing. In our case an occasional student from the College of Business Administration and the Teachers College will register for credit. These students are quite acceptable and do a creditable job in the course, in spite of the fact that the language of the engineer is a little strange to some of them.

In the total program the first thing we notice is a definite increase in "safety-consciousness." This is evidenced by the comments made by the students pertaining to their own problems and, of special interest to us, to our weak spots in the shops and laboratories. Their shop practice improves "safety-wise" along with the acquisition of technical knowledge.

These students soon become teachers of safe practice. They become critical of unsafe acts and of points such as poor housekeeping, unguarded equipment, bad lighting, and the like. They insist that safe practice be more common, not only in the college buildings but everywhere. Many times the things they want to have done in the interest of safety are not brought about as quickly as they feel they should be, and they make it very uncomfortable for the powers that be until something results.

The graduate student seems to be particularly vulnerable in connection with unsafe practice and dangerous situations. This may be because he is now an "educated man" and is beyond criticism pertaining to his *modus operandi*, but it isn't too hard to convince him that he bleeds just the same as an undergraduate student when he is injured. Why he forgets how to put a glass tube in a rubber stopper without jabbing himself is a puzzle, but it seems true that he feels himself beyond the group of potential injuries. Of course there are graduate students who work with material and equipment that are dangerous because of lack of any knowledge concerning the behavior of such equipment or material. Nevertheless, the fundamentals of safe practice are such that they can be used with considerable benefit. Here, more than ever, it is true that habits are cobwebs turned to chains, for if this student has been thoroughly inculcated in the principles of safe practice he will follow them regardless of what material or equipment he is using.

### THE YOUNG ENGINEER IN INDUSTRY

It has been reported that young men entering industry from graduation have difficulty in keeping a safe record during their first six months. If this is so it is an indictment against the engineering colleges. Our product should not be so uninformed concerning safety in the industrial field that they become "babes in the woods" to survive or to perish in their first year.

One may speculate that without good training in college the young engineer may resist safety rules as well as some others and thus become a risk in an otherwise safe industry. In the classroom the student sometimes finds it possible to by-pass certain rules and regulations and still obtain a certain measure of credit for what work he does. In the industrial field such laxness may not be permitted, and his teacher could well be the "old man with the scythe," or the one who hands out pain in large quantities to those who disobey the rules of common sense.

In our College of Engineering and Architecture we have had students state that inspection trips taken before a course in safety and after the course will make the same industry look much different to them. This seems to be evidence that one course in safety will do much to "open the eyes" of a person so that he becomes conscious of the appearance of unsafe acts or of potentially dangerous spots. This type of "eye-opening" should be extremely valuable to any person, engineer or other, who goes into the working field where he comes in contact with forces of production—and with people.

### WHAT SHALL WE DO ABOUT IT?

For those of us in the teaching profession to recognize the existence of a problem such as this and to do nothing about it is very wrong.

We should overhaul our teaching methods in the shop and laboratory courses to be certain that sufficient information is given the new student in that course to make him a safe worker. In addition to the necessary information pertaining to material and equipment that the student uses, he must be trained to perform his learning duties in the safe manner, always. There should be no compromise in connection with acts which can be safe or unsafe. In the earlier days of the student's college career, we should not offer him a choice between safe and unsafe practice. He must be urged to do the job the safe way. The ultimate goal of the instructor should be not only to keep that student hale and hearty at the present but to so thoroughly fix in his mind and in his actions the "safe" way which is always the "best" way to do the job in process.

We must never lose sight of this constant teaching of safe practice regardless of the type of engineering or of the character of the course of instruction.

We must put into every curriculum in the college of engineering a course in "Safety" in which we can discuss the safe practices of industry in general, regardless of what the product of that industry may be. If this course is placed in the senior year the student will have enough background material to permit him to make good applications of the fundamentals of safe practice in many ways. He will have been familiar with shop practice at this time; his knowledge of laboratory techniques should be good; he is close to the period in his life when he must go out among the workers in industry—and thus should be an asset, a safe worker. This special course in Safety will give the student a chance to bring together many of the thoughts pertaining to material and human behavior which he has gathered by the way, but perhaps has never classified. At this time, also, the instructor can bring to the student some of the latest ideas concerning rules and regulations found in industry. Every branch of industry is willing to give this information to teaching personnel for use in the classroom and in the laboratories.

Industry is very conscious of the need for safe workers. It wants its engineers to be safe workers and workers for safety, always.

# *The Life of an* EXCEPTIONAL ECONOMIST[1]


By ELSPETH ROSTOW

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ROY HARROD'S *Life of John Maynard Keynes*[2] provides a valuable introduction to a key figure in the field of recent economics and politics. Only five years after Keynes' death, it is now generally agreed that he was one of the handful of men in any generation to whose existence the world owes a fundamental change, for better or worse, in its pattern of ideas, in its way of thinking. Despite this fact, Keynes' arguments, his main works, have been read and used primarily by economists; the broader public has received the impact of his ideas in dilute form, through the minds and mouths of others. Now for the first time, with the publication of Mr. Harrod's biography, those not primarily concerned with economics can assess the scope and significance of Keynes' life, the nature of his contribution to economics and to politics.

Although economics from time to time has deserved its reputation as the dismal science, Keynes' life was anything but dreary. Born in 1883 to an English intellectual family, educated at Eton and King's College, Cambridge, Keynes early developed an impressive array of interests outside economics: He was a competent mathematician, a reasonably good philosopher, a vigorous patron of opera and painting, an efficient civil servant, a highly successful investor, a brilliant conversationalist, a book collector of note, a serious and scientific farmer, and the husband of one of the outstanding ballerinas of the day. An Englishman to the tips of his sensitive fingers, he spent most of his years in his own country, although his travels took him throughout Europe, to Russia, and to the United States. His friends ranged from the original "Bloomsbury set" (Lytton Strachey, Virginia Woolf, etc.) to civil servants; from artists and dancers to dons and professors; from complicated Europeans to blunt Americans. That he was able to sustain such a diversity of interests and friends while at the same time carving for himself a reputation within his own field is testimonial to his towering intellectual energy; physically, he was not a strong man and his last years were clouded by illness.

Keynes, however, will be remembered mainly as an economist, rather than as an example of twentieth-century multiplicity. From the publication in 1919 of his essay on "The Economic Consequences of the Peace" (in which he deplored the failure of the peacemakers to treat Europe as an economic whole) down to his last assignment as chief negotiator for the United States loan to Great Britain in 1946, he was almost constantly in the public eye; the role he played throughout was that of an economist concerned with and offering policy suggestions on the economic activities of the state. Finding inadequate some of the doctrines on which economics had been resting, Keynes began to study the anatomy of depressions and booms, with a view to preventing the one and sustaining the other (short of inflation). The secret, he thought, would be to maintain full employment through government intervention; specifically, he advocated government adjustment of the interest rate so that investment would be encouraged during a depression with resultant re-employment, and (by a raised rate) discouraged during peak employment periods so as to check inflation. In addition, he felt that government deficits and government-sponsored public-works programs would cushion depressions by stimulating investment and consumption. The echo of these policies during the American New Deal period can easily be heard; oddly, Keynes had less immediate impact on his own country.

The two books in which Keynes developed his major theories were "A Treatise on Money" (1930) and "The General Theory of Employment, Interest, and Money" (1936), of which the second is usually regarded as his chief work. The degree to which Keynes departed from the classical school is still a subject for debate within the profession; it is at least clear that he opened for re-examination a set of assumptions which had previously been regarded as closed. For example, before Keynes, it had been taken as given in the formal propositions of economics that no important difference existed between savings and investment, that is, that funds saved could be regarded as automatically invested. Keynes not only pointed out the inaccuracy of this belief, but also demonstrated that the two functions (saving and investing) are often carried out by different people, for varying reasons.

The immediate effect of Keynes was to polarize economists into two schools—the Keynesians and the anti-Keynesians; government officials tended to divide along similar lines, with the deficit-spenders taking sides against the anti-public-works boys. Now, however, not only have the terms Keynes popularized become common usage among most economists of whatever school ("liquidity preference," "the propensity to consume," "the multiplier," etc.) but also, to take only one example, his distinction between savings and investment has become a part of general economic analysis, with no Keynesian label attached. In fact, it has recently become fashionable for younger economists, using Keynesian arguments and leaning on Keynesian assumptions, to argue that his contribution was not so impressive after all.

As a scientist, Keynes' achievement had a property familiar to the natural scientists but rare among those concerned with the analysis of social affairs. The concepts he used to describe the economic process and its fluctuations have proved, for the most part, statistically measurable. The national budgets of most democratic countries are now related explicitly to the national income and to the components which Keynes isolated as central to its change—in particular, the level of total consumption, the level of private investment, and the surplus or deficit of government. It is the latter item which is most easily subject to control. And one way of defining what is sometimes called the Keynesian Revolution is to say that it has led men to use national budgets as a balance wheel which, at its best, might keep us near full employment while avoiding inflation.

[1] One of a series of reviews of current economic literature affecting engineering, prepared by members of the Department of Economics and Social Science, Massachusetts Institute of Technology, at the request of the Management Division of The American Society of Mechanical Engineers. Opinions expressed are those of the reviewer.

[2] "The Life of John Maynard Keynes," by Roy F. Harrod, Harcourt, Brace and Co., New York, N. Y., 1951 ($7.50, 674 pages).

It is regrettable that so distinguished a man does not have a more distinguished first biography. Mr. Harrod, with access to private papers and letters as well as to most of Keynes' family and friends, has produced a painstaking and admiring account, which sparkles whenever quoting directly from Keynes (there are fortunately many quotations) but tends to plod along when the prose is Mr. Harrod's. The material itself is so absorbing, from Keynes' Victorian boyhood in Cambridge and at Eton down to his last American trip, that the book is well worth reading almost in spite of itself. For it introduces Americans to a man who has helped to shape their society and to influence their economy for at least a generation and probably longer. Since, in addition to presenting Keynes, the book also provides a guide to his generation and its vivid intellectual life, no one interested in the peculiar political, economic, and social configurations of our century can afford to ignore it. There will be other biographies of Keynes later, and perhaps better ones, but for the time being this is a book to read.

## Forging Munition Shells

(*Continued from page 808*)

away with mountains of chips which had to be raked, shoveled, drained, crushed, hoisted into railroad cars, and shipped back to an open-hearth furnace. Operators of such furnaces do not like chips; they call them hay. Freight has to be paid twice on the chips, from and to the steel plant. The cold-forging process does away with long lanes of shell-turning lathes.

Time will tell whether or not these advantages are sufficiently great to result in the general adoption of the cold-forging process.

Early in 1950 it became known that the field of extrusion of hot steel had been greatly extended by using a special glass as a lubricant and heat insulator between hot steel and die. This discovery, which was made in France, may possibly be of some use in the hot-forging of shells. Up to now no experimentation along that line has become known.

### CONCLUSION

In each step in the hot forging of shells, from billet separation to nosing, many small details must be observed if acceptable forgings are to be made at low cost. It is utterly impossible to cover all these details in an engineering paper. Any concern that contemplates forging shells by the hot method will find it very profitable to study the ASME reports[1] which were mentioned in the early part of this paper.

## Fluid Hydroformer

THE world's first fluid hydroformer, currently being engineered by the M. W. Kellogg Company, New York, N. Y., will be able to convert 55-octane virgin gasolines into 98 to 175-octane aviation gasoline, it was announced by Kellogg. The plant, a 2000-bbl per day unit, is to be located at the Destrehan (La.) refinery of the Pan-Am Southern Corporation. Process design has been completed and construction is scheduled to start in the near future.

Low-octane virgin gasolines have been a problem to refiners for years. While they can be disposed of by blending into the house-brand motor fuel, their low-octane ratings exert a depressing effect on the quality of the over-all product, making it less acceptable to the consuming public. Many refiners in the past have built units to thermally reform the naphthas. This method, while adequate, produces lower yields of lower-octane materials than catalytic reforming, of which the fluid type of hydroforming is the newest arrival. Pan-Am's fluid hydroformer, for example, is designed to process 55-octane naphtha and raise its octane to 95 CFR-R (Clear, i.e., without addition of tetraethyl lead) which puts the final product in the aviation gasoline category.

The fluid hydroforming process is based on extensive development work by Standard Oil Development Company, Standard Oil Company (Indiana), and the Kellogg Company. It applies the fluid-catalyst principle (finely powdered catalyst supported on vapors and acting as a turbulent fluid) to the reforming of naphthas. This is the same principle which has been widely adopted throughout the world in the catalytic cracking of gas oils to produce high-octane gasoline.

The new process is said to have several advantages over the fixed-bed hydroformers built during the World War II emergency to provide vast quantities of toluene and avgas. In these earlier hydroformers, reaction beds had to be alternately taken out of product production while the catalyst was regenerated. The new fluid-catalyst system continuously withdraws catalyst from the reaction zone and regenerates it simply and cheaply. Daily operating costs will be approximately 30 per cent lower than those of a fixed bed with the same capacity. Furthermore, Kellogg estimates that this new type of unit will cost one third less to build for equivalent capacities.

In the operation, fresh feed is charged to an absorber from which it passes through exchange to the main heater where its temperature is raised to approximately 950 F. From there the feed is charged to the base of the reactor in which the fluid bed is maintained. The vaporized naphtha passes up through the bed (where the hydrocarbon molecules are reformed from straight-chain paraffins to ring-type aromatics) and into the separation section above the bed level. After passing through cyclones at the top of the reactor to remove entrained catalyst, the reformed hydrocarbon vapors are transferred to the main fractionating tower and introduced at a point just above the slurry settler.

Taken off as bottoms from the tower is a certain small amount of relatively high-boiling-point polymer made during the processing. This is charged to a flash drum and recovered separately for petrochemical processing.

Principal product leaves the fractionator overhead and goes to a high-pressure receiver which separates the hydrogen-rich gases from the gasoline. The gasoline is stabilized and sent to storage. The gases, after passing through heat exchangers, are recycled to the base of the reactor to maintain the required hydrogen-rich condition in the reaction zone.

The movement of the fluid catalyst is similar to that in fluid catalytic cracking. From the reactor it passes through a stripper to remove and save hydrocarbon product and is then charged to the regenerator where the coke is burned off before it is returned to the reactor. Heat generated in regeneration is used to produce process steam through the use of an integrally contained boiler.

Varying operating conditions produce different yields and octane ratings. Under severe operation, the octane rating of the product is 95 CFR-R (Clear).

Operating for the prime purpose of producing avgas base stocks, the aviation octane ratings reach 98, F-3 and over 175, F-4, with the addition of 4.6 cc of TEL per gal.

In actual refinery practice, through blending of extraneous butanes, the total volume of finished gasoline approximates 100 per cent of the liquid charge volume.

# *BRIEFING THE RECORD*

## Abstracts and Comments Based on Current Periodicals and Events

COMPILED AND EDITED BY J. J. JAKLITSCH, JR.

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context, and credit to original sources is given.

## Fuel-Engineering Education

WHAT is being done today on fuel-utilization instruction in engineering schools was discussed by C. C. Wright, professor of fuel technology, The Pennsylvania State College, State College, Pa., at a Fuels Division technical session during the 1950 ASME Annual Meeting.

#### FUEL ENGINEERING TRAINING IN ENGINEERING COLLEGES

Professor Wright said that an evaluation of the fuel-utilization training in engineering colleges is complicated by the fact that the work offered by different departments within a college is generally available only to students of that particular curriculum. This is due to the prevailing tendency of crowding into the four-year engineering curriculums the maximum number of required courses, and limiting electives to two and three courses. The situation is further complicated by the fact that much of what is offered on fuels and their utilization is given as part of general courses on other subjects such as power engineering, industrial heating, blast-furnace operation, kiln firing, etc., where the portion relating to fuels is frequently only a minor fraction of the over-all course.

The field of fuel utilization borders on the fields of a number of the older established branches of engineering, he said, but is not the specific province of any one.

At the undergraduate level, Professor Wright reported that training in fuel and fuel utilization receives meager treatment in all but a few colleges. Except for one specialized fuel-technology curriculum, in which approximately 13 per cent of the total training pertains specifically to fuels and their utilization, the extent of such training averages about 2 per cent for mechanical-engineering curriculums and about $1^1/_2$ per cent for chemical-engineering curriculums. A limited few mechanical-engineering departments, however, require from 5 to 7 per cent of such training and others offer a similar amount as electives. Analysis and combustion are the principal fields of the subject covered, but most of the departments do not require an adequate background in chemistry to permit more than empirical or descriptive treatment of the subject of fuel utilization.

He found that at the graduate level most of the work on fuels and their utilization appears to be handled in chemical-engineering departments. In a few schools, however, such training is offered by fuel technology, metallurgy, or mining departments. Emphasis is still placed on combustion, but thermal and chemical processing also receive adequate treatment.

According to Professor Wright, those institutions offering a graduate program on fuels and their utilization are in most instances also the ones with the most extensive research programs in the field. Many other institutions include research training in specialized phases of the field, however, and contribute to the over-all training of students and research workers

#### WHAT ENGINEERING SCHOOLS SHOULD TEACH ABOUT FUEL UTILIZATION

That engineering colleges are interested in fuels and fuel utilization is evidenced by the fact that the 1949 Review of Current Research by the Engineering College Research Council of the American Society of Engineering Education lists 248 projects in these fields. This was pointed out at the same session by A. A. Potter, dean of engineering, Purdue University; president, Bituminous Coal Research Inc.; and past-president and Honorary Member ASME. Typical fuel-research problems under way in engineering colleges are coal combustion, cleaning, handling, hydrogenation, pulverizing, processing, utilization, washing, coke manufacture, oil prospecting, oil production, oil-shale processing, petroleum coke, petroleum recovery, natural gas, and peat, according to Dean Potter.

While the present trend in engineering education is definitely away from specialized courses in undergraduate programs, he said, it is essential that the engineering student appreciate the place of mineral fuels in power production, steel manufacture, transportation, and the chemical industry.

The engineering student in all curriculums should be introduced to fuels in the first course in heat power required of sophomores or juniors. The topics to be included in such a course are fuel resources and their utilization; physical and chemical characteristics of solid, liquid, and gaseous fuels, and principles of combustion Fuel-burning equipment for power

### How to Obtain Further Information on "Briefing the Record" Items

**MATERIAL for this section is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.**

**For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources: i.e. (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.**

generation and industrial purposes should also be covered in the elementary heat-power course required of all students.

Chemical-engineering students should learn about the importance of chemicals arising from coking of coal to make coke and coal products, such as coal gas, benzene, ammonia, etc. They should be familiar with coal gas, water gas, and producer gas.

Students in mining should devote more time than those in mechanical, electrical, and chemical engineering to the study of the origin, occurrence, range, composition, and physical characteristics of coals, liquid and gaseous fuels. Students in metallurgical engineering should be familiar with the applications of coal and coke to metallurgical operations, with special reference to the use of fuels in iron and steel manufacture. They should study combustion devices, by-product coke production, combustion problems utilizing solid, liquid, and gaseous fuels, and instrumentation for temperature and humidity control in furnaces.

Mechanical-engineering laboratory experiments should familiarize the student with sampling and testing of fuels, analysis of the products of combustion, and heat balances for complete plants.

Hydrocarbon fuels should be covered more in detail in connection with instruction in internal-combustion engines. Developments in gas engines, jet propulsion, and rockets require additional instruction in fuels for advanced students.

Dean Potter emphasized that elective courses in fuels and fuel utilization for senior and graduate students are desirable. He referred especially to coke manufacture and use, coal preparation and sizing, pulverization of coal, fly-ash recovery and disposal, coal storage, coal gasification, mixture properties of petroleum fractions, fuel-burning equipment, transportation of fuel, and combustion controls. Fundamentals of gaseous reactions, chemical equilibrium, flame problems, the mixing of high-velocity fluid streams, furnace and burner design, heat transfer, mass transfer, and similar topics should be covered in courses open to graduate students.

In a few engineering colleges, he said, it may be desirable to set up special programs in fuel technology leading to advanced degrees to cover more extensively coal petrography, chemical constitution, classification, preparation, carbonization, processing, utilization, and physicochemical properties of coal; synthesis of liquid fuels, chemical processing of fuels, and fuel-technology design.

An appraisal of the undergraduate curriculums of eight recognized engineering colleges leads to the conclusion that fuels are treated adequately for the majority of undergraduates, but that more attention should be given in selected institutions to graduate programs in fuel technology and to research in this field which is essential to our national welfare and security.

# Engineering Physics

THE wide dissatisfaction of mechanical-engineering teachers with present physics courses is very real and it has a definite cause, according to Prof. Neil P. Bailey, Fellow ASME, head, mechanical-engineering department, Rensselaer Polytechnic Institute, Troy, N. Y. Now, just as in 1900, the content of engineering physics courses is concerned largely with mechanics, heat, and electricity. In the meantime, since 1900, the content of engineering science courses has evolved steadily. The result is a situation which demands immediate and effective correction, Professor Bailey states.

The mechanics of solids and fluids is taught both in physics and in the engineering-science courses of the mechanical, aeronautical, and applied-mechanics departments. Heat is taught in physics courses and again in mechanical-engineering courses. Physics departments and electrical-engineering departments both teach the same students electric and magnetic circuits. In practically all cases the engineering departments are covering more thoroughly the exact subject matter covered quite hurriedly in physics courses.

### ENGINEERING SCIENCE AND PHYSICS COURSES

Professor Bailey points out that the teaching of those areas of applied science which at any time are the bases from which new products, processes, and procedures are being currently evolved is conceived as the indisputable province of engineering-science courses. This is proper because such courses will be best taught by those who are currently using them. It is not at all necessary or desirable to teach them both as pure sciences and again as applied sciences.

Currently, these subjects include mechanics of solid bodies and fluids; heat, calorimetry, and thermodynamics; and electric and magnetic circuits.

The responsibility of physics courses to mechanical-engineering students may be broadly stated as the teaching of those areas of current or modern physics which give greatest promise of becoming tomorrow's engineering science, he said. This suggests such subjects as modern theories of matter, wave motion, and field theory, and energy transformation including nuclear physics.

Today's physics has no responsibility for the teaching of today's engineering science. Today's physics should be the basis for the development of engineering science which must be accomplished tomorrow by today's engineering students, Professor Bailey declared.

Engineering physics as currently taught seems to be conceived as the culture of the blossoms of this year's fruit. It more properly should be the growth of new wood for the production of next year's fruit, he said.

### LESSONS FROM HISTORY

The year 1908 was a very significant one in mechanical-engineering education, according to Professor Bailey, for in that year the United States Patent Department ruled that future patent applications for perpetual-motion devices must be accompanied by working models. This move marked the progress of mechanical-engineering applied science from the concepts of the equality of forces and moments to a belief in the persistence or conservation of energy. It dates the transition from eighteenth-century physics to nineteenth-century physics in mechanical-engineering thinking, and it is significant that it was half a century behind the physics of that day.

Since that time applied engineering science has made great progress in the fields of mechanics, heat, and electricity. However, the engineering physics of this same period has remained the Spanish-American War variety, he said, and present-day mechanical-engineering students are still being denied an insight into twentieth-century physics. It is this physics of the structure of matter and the nature of energy from which these same students must evolve the new products, processes, and procedures of their day.

### CURRICULUM PROPOSALS

To correct this situation the following two broad mechanical-engineering curriculum changes are proposed by Professor Bailey:

1(*a*) That the teaching of the mechanics of solids and fluids be done exclusively in the applied-engineering-science courses of mechanical engineering and applied mechanics departments; (*b*) that mechanical-engineering heat and thermodynamics courses accept full responsibility for the teaching of all heat,

calorimetry, and applied thermodynamics; and (c) that present electrical-engineering courses be expanded to care for all of the electricl and magnetic-circuit theory.

2(a) That an adjusted amount of physics instruction be scheduled in the late sophomore, junior, and senior years; and (b) that this physics be concerned exclusively with the most up-to-date areas of twentieth-century physics of matter and energy concepts.

It is high time, Professor Bailey concluded, that repetitive and competitive teaching of today's engineering science be discontinued and the lost time be used to teach today's physics to prepare for tomorrow's applied science.

# Technical Institutes

THE seventh "Annual Survey of Technical Institutes for 1950-1951" has been prepared by Leo. F. Smith, chairman, and Maryfrances Dudley of the Educational Research Office, Rochester Institute of Technology, and appears in the May, 1951, issue of *Technical Education News*.

In the present survey, enrollment figures are included for 66 schools, which is the same number that reported last year, although not all the schools are the same as those reporting a year ago. This year the institutes were asked to indicate those curriculums accredited by the Engineers' Council for Professional Development. Because of some confusion in reporting, enrollment in those courses is not listed separately as planned.

In the 66 schools reporting, 24,345 regular day students were enrolled as of Jan. 2, 1951. This represents a decrease of 24.9 per cent as compared with 32,435 students in 1949-1950. In addition, 22,096 evening and special students were reported this year, an increase of 10.1 per cent over the 20,073 reported last year. The grand total of 46,441 reported this year is a decrease of 11.6 per cent as compared with 52,508 in 1949-1950. Enrollment in the Canadian schools is not included in these comparisons.

### MARITIME ACADEMIES AND FEDERAL SCHOOLS

The regular day enrollment in the state maritime academies and federal schools shows 327 in the two schools reporting as compared with 1090 reported by four schools one year ago. The U. S. Maritime Service Training Station at St. Petersburg, Fla., was decommissioned and closed on June 30, 1950.

The U. S. Maritime Training Station at Alameda, Calif., reports a new planetarium with a 20-ft hemispherical dome.

In addition, the U. S. Maritime Service Institute reports that as of Dec. 31, 1950, the Institute had 7476 students taking correspondence courses. During 1950 the Institute awarded 1282 completion certificates, corrected 41,653 lessons, and registered 5013 new students. A total of 45 courses are available for study.

### STATE, MUNICIPAL, AND ENDOWED INSTITUTES

A regular day enrollment of 8167 in 16 state and municipal institutes reported, compared with 9091 reported in 18 such institutions last year.

California State Polytechnic College reports an interesting course in agricultural journalism for young men with a farm background who like to write.

In New York State, the Long Island Agricultural and Technical Institute at Farmingdale has a $2,300,000 industrial-technical building under construction. The Morrisville Institute has a new men's dormitory and a gymnasium-auditorium under construction.

A regular day enrollment of 3434 students in the nine privately endowed institutes is reported, compared with 3983 reported in nine schools one year ago.

The Rochester Institute of Technology reports a new $250,000 web-offset-press laboratory that will be used for instruction and research.

Spring Garden Institute is celebrating its centennial.

### EXTENSION DIVISIONS OF COLLEGES AND UNIVERSITIES

A regular day enrollment of 2306 in the extension divisions of five colleges and universities is reported as compared with 2700 reported by five institutions last year.

Purdue University reports that a new $500,000 center is under construction at Hammond, Ind.

Utah State Agricultural College reports a new course in industrial safety.

The University of Wisconsin reports that a wide variety of industrial-management institutes have been held from time to time during the past year.

### PROPRIETARY TECHNICAL INSTITUTES

The regular day enrollment in the 23 schools reporting is 9864 as compared with 14,784 reported by 23 schools a year ago.

Cal-Aero Technical Institute reports a new course in jet-engine maintenance and overhaul.

Milwaukee School of Engineering announces that a four-story building has been acquired, which will provide additional space for classrooms, laboratories, and a student union.

The Bliss Electrical School closed after 57 years of operation, and the plant has been sold to the Board of Education, Montgomery County, Md.

### YMCA SCHOOLS

Enrollment figures from the three YMCA schools reporting, showed a total of 247 regular day students, compared with 787 reported by the same schools last year.

### CANADIAN SCHOOLS

The enrollment in seven Canadian schools of 2215 for this year compares with 1106 reported by six schools a year ago.

The École Provinciale de Papeterie reports a new paper-and-pulp mill that will be ready for operation next September.

### CONCLUSIONS

The following generalizations are drawn from this survey:

1 Enrollments in the day programs are down markedly (24.9 per cent), and although the evening and special enrollment has increased somewhat (10.1 per cent), the total enrollment has decreased 11.6 per cent as compared with a year ago.

2 Several new buildings and additions were reported, and it appears that some of the institutes are taking aggressive steps to improve their facilities.

3 The New York State Institute of Applied Arts and Sciences at Brooklyn reports the largest day enrollment with 2173 students, while the Rochester Institute of Technology has the largest total day and evening enrollment with 4445 students reported.

# Radial Shaft Seals

THE improvements and advancements in the technique of preventing leakage of fluids, gases, lubricants, and foreign materials through revolving-shaft openings in bearing housings, gearboxes, hubs, etc., by means of the unitized radial-contact shaft seal were outlined by E. F. Riesing, Mem. ASME, industrial manager of sales engineering, and H. H. Klein, Detroit district engineer, National Motor Bearing Company, Detroit, Mich., before a joint Rubber and Plastics and Machine Design

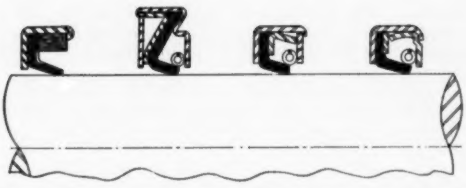


FIG. 1 CURRENTLY AVAILABLE STANDARD LEATHER CONSTRUCTED UNITIZED RADIAL SHAFT SEALS

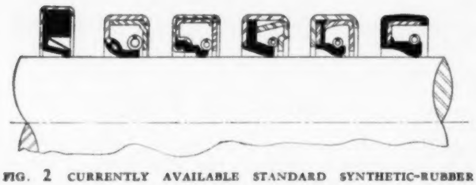


FIG. 2 CURRENTLY AVAILABLE STANDARD SYNTHETIC-RUBBER UNITIZED RADIAL SHAFT SEALS

Division technical session at the 1950 ASME Annual Meeting.

While rag and hemp packings and stuffing boxes sometimes sufficed in early days, the authors said, the art of sealing shaft openings has advanced today to the modern unitized radial-contact shaft seal closure. Today these closures are available in many sizes in both standard and special constructions, with a multiplicity of features capable of successful and efficient sealing performance under practically all operation conditions. While other fundamentally different types of seals, such as the "axial-face type," are required for some unconventional sealing conditions, the radial-contact type is so generally utilized that it represents the basic type for all industrial and vehicular usage.

The modern unitized radial-contact shaft seal is also called upon to keep different fluids and gases separated, where revolving shafts extend from one chamber into another; also to exclude water and silt from submerged shaft bearings, and to prevent bearing lubricants from contaminating products in food-processing industries. The responsibility accorded unitized shaft seals today is further burdened by the variable conditions of extremely high and low shaft speeds, direction reversal, high and low operating temperatures, positive and negative pressures, vibration, shaft distortion, percussion and flutter, as well as conditions of run-out and misalignment.

Radial contact shaft seals are currently in operation on shafts or in bores, rotating from 1 rpm to 10,000 rpm, at peripheral speeds from less than 1 fpm to 5000 fpm, and at temperatures ranging from —60 F to +400 F. Some of these installations impose pressure conditions ranging from positive pressures as high as 300 psi down to negative pressures of 14 psi; others introduce shaft run-out conditions as high as 0.060 in. total indicator reading, up to 0.050 in. off-center shaft conditions, plus lateral shaft end play.

The resilient materials employed for the sealing member are basically leather, cork, felt, fabric, plastic, and various compounded organic and inorganic synthetic resins and elastomers. Some of these are combined to form composite elements such as synthetic rubber-coated felts, leather and plastic laminates, fabric-faced or fabric-reinforced synthetic rubbers, synthetic-resin-impregnated leathers, synthetic-rubber-impregnated leathers and fabrics, and the like. It should also be noted that some of these materials are especially prepared with waxes and oils.

# Natural-Gas Pipe Lines

PIPE-LINE construction is booming as natural-gas customers increase, according to *The Constructor*, July, 1951. For example, total pipe-line mileage in the United States at the beginning of 1951 was approximately 460,000 with an additional 25,000 miles expected to be constructed this year by American firms both at home and abroad.

In 1950, more than 16,000 miles of projects were completed. Of this total, 10,623 miles were for natural gas, 3214 for crude oil, and 2444 for refined products. These lines range in size from 2 in. in diam to 34 in. and cost an average of $130,000 per mile.

Biggest boom in pipe-line transportation has been in the natural-gas industry which, between 1945 and 1950, has constructed or been authorized to build more than 26,000 miles of line. The largest customer area still to be touched is in New England. Current plans, which may be held up during the emergency, are to run lines as far north as Maine.

Of the total fuel energy consumed in this country, natural gas now accounts for about 20 per cent, an expansion of over 20 per cent in this fuel in the last 25 years. In a 10-yr period ending in 1954, more than $6 billion is expected to have been invested in natural-gas facilities.

Here are some of the major lines in the country, most of which stem from the gas-rich fields of central and southern Texas:

The Tennessee Gas Transmission Company, Houston, runs a 3197-mile line whose main stem extends from the southern tip of Texas to Buffalo. Slowly curving through the southeastern states from the Rio Grande to New York City are the 1832 miles of line constructed for the Transcontinental Gas Pipe Line Corporation of Houston. Also linking Texas to New York is the mammoth 3267-mile system of the Eastern Transmission Corporation, Shreveport. Originating at El Paso, 4861 miles of pipe of the El Paso Natural Gas Company sprawl west to Arizona and northeast to lower Lake Michigan at which point the line forks into northern Michigan and Wisconsin. Most extensive is the 7966-mile spider web of pipe controlled by the Union Gas Pipeline Company of Shreveport, confined mostly to Texas and Louisiana.

The most amazing part of the pipe-liner's story is the continued rapid expansion of service in the face of almost insurmountable obstacles, *The Constructor* stated.

First, supplies of natural gas are uncertain. Though gas reserves are estimated to last only about 30 years, it is not uncommon for a large source of gas supply to suddenly become depleted. Second, natural gas, on a thermal-unit basis, cannot compete with coal and has only a slight advantage over oil. However, gas, unlike these other types of fuel, requires no storage facilities and leaves no waste. Third, though the price of gas has decreased, the cost of line facilities has doubled since 1940.

# Coal Pipe Lines

ABOUT $10,000,000 would build a pipe line 100 miles long capable of transporting 5000 tons of coal a day with water, according to estimates in a Bureau of Mines report made public by Secretary of the Interior Oscar L. Chapman. After the pipe line was completed and in operation, the estimated cost of moving the coal over the 100-mile journey would be between $1.28 and $1.91 a ton.

Similar construction and operation cost estimates are given

for the same length pipe line moving larger tonnages of coal, ranging up to 36,000 tons a day. The construction costs rise for the larger-capacity pipe lines naturally, but transportation costs per ton go down, the report shows. For instance, the estimated cost per ton of moving coal in the 36,000-ton a day line is only 38 to 95 cents.

Since detailed estimates cannot be prepared without additional technical information, the Bureau's figures are based entirely on a preliminary study of the known factors, the report points out. The estimates, purposely made conservative, include the major costs involved in the construction and operation of coal pipe lines.

Transporting coal with water in pipe lines has intrigued the industry and coal technologists for over half a century, the Bureau points out. Because of certain technicalities it has never been adopted on a large scale, although several enterprising concerns have built and operated short lines for transporting certain types of coal. The first American patents covering a method of pumping coal with water through pipe lines were granted in 1895 and 1905, and the subject has been one of recurring interest since that time.

The latest development is an announcement by a large coal company of plans to build a full-scale demonstration pipe line in Ohio through which finely ground coal will be mixed with water and pumped. The proposed line is to be a 12-in. pipe, 17,000 ft long. This announcement was made after the Bureau completed the survey described in the current report.

However, there still remain many pump-performance and behavior of water-coal mixture problems that can be solved only by actual performance tests, the Bureau notes in its report.

A brief historical account of the hydraulic transportation of coal, a review of published literature on the subject, a résumé of industry opinion, economic studies, and the cost estimates on 100-mile pipe lines of varying capacities are also included.

A free copy of Report of Investigations 4799, "Survey on the Hydraulic Transportation of Coal," by R. W. Dougherty, may be obtained by writing to the Publication Distribution Section, Bureau of Mines, 4800 Forbes Street, Pittsburgh 13, Pa. The report should be identified by name and number.

## Universal Shearing Machine

PRELIMINARY tests show that a compressed-air-operated German universal shearing machine that the Bureau of Mines imported for experimentation promises to be a useful tool for mechanized mining of steeply pitching anthracite beds, according to a report released by the Department of the Interior.

The Korfmann universal shearing machine, model SK 20, is track-mounted, and it is of the conventional cutter-bar-and-chain type. However, the cutting mechanism can be rotated to cut in any direction. The machine weighs about a ton and a half.

The tests reported were made in an anthracite mine the operators of which are co-operating with the Bureau in its efforts to develop a method of mechanical underground mining adapted to the Pennsylvania anthracite region, especially to speed up the development of gangways. The tests were conducted to determine the power characteristics of the machine and its maneuverability and effectiveness when used in anthracite mining.

The machine was tested under various conditions, and power curves were developed. The authors of the report, John W. Buch and Andrew Allan, Jr., Bureau engineers stationed at Schuylkill Haven, Pa., conclude that the machine would aid in increasing the rate of gangway driving, and its performance warrants additional experimentation using a definite mining method. They suggest some modification, noting that a compressed-air-operated crawler-tractor mounting is being designed. This would increase its maneuverability, especially important in gangway work.

Comparison of this machine with the smaller lower-powered Bickhoff shearing machine which the Bureau also has tested, shows the latter is more maneuverable but will make only shear, i.e., vertical cuts.

Photographs, graphs, and diagrams supplement the text of the Report of Investigations 4794, "Anthracite Mechanical Mining Investigations—Progress Report 3; Preliminary Testing of the Korfmann Universal Shearing Machine, Model SK 20." Copies of this report can be obtained from the Bureau of Mines, Publications Distribution Section, 4800 Forbes Street, Pittsburgh 13, Pa.

## Lignite for Fuel

AFTER nearly two years of research, the Bureau of Mines has unveiled a new process that offers promise of making the West's immense reserves of lignite and other low-rank noncoking coals a major source of both low-cost electric power and coal-tar products.

Soon to be applied commercially in providing fuel for power generation at Aluminum Company of America's new aluminum smelting plant in Texas, the process was developed in the Bureau's coal-branch laboratories and pilot plants at the Denver Federal Center under a co-operative agreement with the Texas Power and Light Company.

Major products of the process, a variation of low-temperature carbonization, are a high-heating-value char ideal for power plant use and crude coal tar, which is the source of a myriad of by products, including wood preservatives, plastics, explosives, drugs, and dyes.

According to V. F. Parry, chief of the Denver Laboratories, the process offers a great opportunity to thermal power-plant operators throughout the West. It is applicable to any coal of lesser rank than high-volatile bituminous B, a bracket that encompasses 90 per cent of all Western coals, he said.

If merely an average Western coal is used, the value of the tar recovered—at least 8 to 10 cents a gal—alone is equal to the cost of the raw coal, Mr. Parry stated. The more favorable coals will yield as much as 45 to 55 gal of tar oil per ton. Indicated processing costs are relatively nominal, and the char remaining thus can compete with natural gas as a fuel.

According to calculations, he continued, based on pilot-plant results, profits from the 14 gal of tar recovered from a ton of Milam County, Texas, lignite will enable even this fuel to compete with natural gas selling at 5 to 8 cents per 1000 cu ft.

ALCOA's new plant in Milam County, Texas, will have a capacity of 85,000 tons of metal annually with initial production scheduled for the fall of 1952. When in full operation, the plant will employ about 1000 persons.

The large amounts of electricity required by the new plant will be generated by steam-driven equipment using as fuel lignite processed by the Bureau's carbonization method. Power-generating facilities will be built and operated for ALCOA by the Texas Power and Light Company.

The Bureau of Mines has designed for the Texas Power and Light Company a 575-ton per day lignite processing unit, which is patterned after its own two pilot plants, 5 and 25-ton per day units that have been proved by test operations at the Denver Federal Center. A battery of twelve 575-ton per day units, costing approximately $9 million, will be needed to supply fuel for generating the power required by the new ALCOA aluminum smelter. Using nearly 7000 tons of lignite daily, they

would produce some 3200 tons of char and 2300 bbl of tar.

Reserves of lignite in Milam County are known to total more than 100 million tons, and exploration work now in progress is expected to add to this figure. It can be extracted both by strip and slope mining at an estimated cost of only $1 to $1.50 a ton, which aids materially in enabling lignite to compete with natural gas for power production.

Raw lignite, containing some 35 per cent moisture, has a heating value of 7000 Btu per lb, Mr. Parry said. However, the bone-dry char, obtained after processing this lignite, has a heating value of 10,600 Btu per lb. Although having only 45 per cent of the weight of the raw lignite, the char retains 75 per cent of the heating value. This obviously advantageous shipping factor ultimately may mean that char processed from mountain-state coal will be shipped to the west coast to fuel power plants and industry there when fuel oil becomes short.

In the Bureau's process, Mr. Parry said, lignite or other low-rank noncoking solid fuel is crushed to $^1/_4$-in. particles or smaller. To remove the moisture, the crushed fuel is "boiled" at 350 F in a fluidized drier developed here that uses the hot products of combustion or flue gas as the heating medium. Then the hot dry fuel is moved pneumatically to a carbonizing reactor, where it is burned with air at a temperature of 950 F to extract the tar oils and obtain a char. This transformation, it is believed, can be made at an over-all thermal efficiency of about 91 per cent.

The process also is applicable to synthetic-liquid-fuels production in two ways, the Bureau disclosed. First, it yields tar oils that readily can be hydrogenated, using relatively little hydrogen, to produce quality synthetic liquid fuels ranging from heavy industrial fuel oil to aviation gasoline. Second, the carbonizing equipment can be used to extract oil from shale fines now discarded because they cannot be handled in most of the pilot-plant shale retorts under study.

Mr. Parry is convinced that the processing of noncoking Western coals is necessary to achieve the lowest-cost power. He also believes it essential to integrate power production in the West with the manufacture of synthetic liquid fuels ".... because of the many advantages in extraction of tar before burning the charred residues for power."

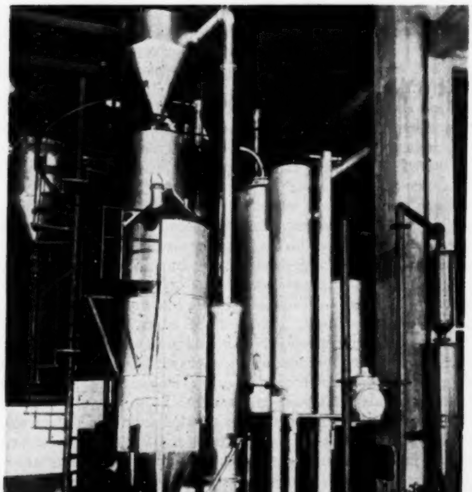


FIG. 3 BUREAU OF MINES PILOT-PLANT LIGNITE-PROCESSING UNIT

(A modern power plant containing large carbonizer units patterned after this 25-ton per day pilot plant at the Denver Federal Center could convert raw lignite to electric power and crude tar in less than 20 min. This includes the time necessary to crush, dry, carbonize, and burn. Fine lignite would be handled as a fluid and pumped through the plant.)

# Chromium Plating

## *Chromium-Plated Steel*

CHROMIUM plating, because of its hardness and ease of application, is widely used on all types of machine elements to protect softer metals from wear and to salvage worn or undersized parts. However, the advantages of chromium plating are sometimes offset by a reduction in the ability of the basic metal to deform plastically without breaking. To learn more about the effect of chromium plating on the plastic deformation of steels used in aircraft, Hugh L. Logan, of the National Bureau of Standards, recently made a comprehensive study of the mechanical properties of chromium-plated SAE 4130 steel.

The NBS investigation included tensile, tensile impact, bending, and crushing tests of specimens prepared from rod and tubing of SAE 4130 chromium-molybdenum steel heat-treated to a hardness of about 40 Rockwell C scale before the final machining. Some of the specimens were tested as machined, without plating; others were tested after plating to one or more thicknesses; and still others after both plating and subsequent baking at various temperatures up to 440 deg C. The effect of baking was of interest since the usual commercial practice is to bake chromium-plated steel articles at a temperature of 200 deg C for several hours after plating. Chromium was deposited from a bath containing 250 grams per liter of $CrO_3$ and 2.5 grams per liter of $H_2SO_4$ and maintained at 55 deg C; a current density of 350 amp per sq ft was used.

The data obtained in all except the tensile-impact tests indicate that chromium plating appreciably reduces the plastic deformation that can occur in SAE 4130 steel before fracture. Generally, however, the ability of the plated specimens to undergo plastic deformation was substantially increased by baking at temperatures between 100 and 440 deg C.

Tensile tests were made on specimens plated to nominal thicknesses of 0.0001 to 0.015 in., as well as on the unplated specimens. Average values for the tensile properties of the unplated steel were as follows: Tensile strength, 187,300 psi; yield strength, 175,900 psi; elongation in a 2-in. length, 13 per cent; true stress at beginning of fracture, 270,900 psi; original area of specimen divided by area at beginning of fracture, 2.088. It was found that the tensile and yield strengths decreased with increasing plate thickness until, at a thickness of 0.015 in., the values were about 90 per cent of those for the unplated steel. Baking at 200 and 400 deg C did not produce any appreciable change in these properties. Plating to a thickness of 0.010 in. reduced the true stress at beginning of fracture to about 80 per cent and the percentage elongation and true strain at beginning of fracture to less than 60 per cent of that of the unplated steel. However, the baking of plated specimens at 200 or 440 deg C appreciably increased the values obtained for these properties.

Tensile-impact tests were made with the co-operation of the New York Naval Shipyard. These tests were conducted at room temperature; the striking velocity was 27.8 fps. The unplated steel elongated 15.8 per cent, absorbing 464 ft-lb of energy at failure; reduction in area was 55.2 per cent. The tensile-impact properties of plated specimens were 93 per cent or more of those of the unplated steel and were not appreciably changed by baking at temperatures up to 300 deg C.

Bend tests were made in a universal testing machine on specimens having a diameter (before plating) of 0.500 in. and a length of 10 in. Although unplated specimens could be bent as far as possible in the machine without failure, specimens plated to a thickness of 0.015 in. failed after they had been bent through an angle of about 40 deg. On the other hand, plated specimens baked at temperatures of 200 to 440 deg C could be bent through angles of 70 to 85 deg before failure. The moduli of rupture of plated specimens baked at these temperatures were equal to that of the unplated steel.

In crushing tests, specimens machined to close tolerances from heavy-walled tubing were tested either as machined, after plating on the inside and outside surfaces to a thickness of about 0.010 in., or after plating to this thickness, and baking at temperatures between 100 and 400 deg C. The specimens were tested to failure by compression between the stationary and movable heads of a universal testing machine in which the load was applied along a diameter of the tube. Plating increased the load necessary to crush the specimen by a factor of about 1.2 and reduced the deformation at failure to approximately 9 per cent of that of the unplated steel. Baking at temperatures of 200 to 400 deg C increased the load necessary to produce failure about 1.4 times and increased the deformation to about 55 per cent of that of the unplated steel.

It is possible that hydrogen deposited with the chromium during plating may be a factor in reducing the amount of plastic deformation that the steel can withstand before fracture. Baking of plated specimens removes hydrogen from the chromium and hence may be expected to increase the ability of the steel to withstand plastic deformation.

### *Chromium-Plated Aluminum*

A new process which permits the plating of chromium directly onto aluminum has been perfected recently, according to the *Aluminium News*. Chromium-plated aluminum has long been recognized as a strong and mechanically attractive combination that is highly suited for applications that require the lightness and corrosion resistance of aluminum together with the hardness, wear resistance, corrosion resistance, and antifriction qualities of chromium.

Due to this combination of lightness and wear resistance, chromium-plated aluminum, often in the form of castings, is particularly useful on all kinds of transportation equipment and for portable products. Plated aluminum is widely used for gears, ball bearings, ring seals, pulleys, electric parts, and plug gages.

The basis of the method, developed by Cro-Plate Inc., involves the use of an abrasive material suspended in water for cleaning and finishing the metal surface by wet-blasting. After blasting, the mechanically cleaned aluminum surface retains a coating of the suspension thick enough to prevent oxidation for a sufficient period to permit the aluminum to be immersed in the plating bath. Once in the acid bath, the blasting coating washes away and settles to the bottom of the tank.

With this coating out of the way, plating follows the normal pattern with the chromium deposited directly onto the aluminum—without an oxide coating or other separating layer between base and plated coating. To insure maximum efficiency, the blasting machine is placed next or near to the plating tank.

Possible drawbacks to this method, which otherwise has many advantages, include the short length of time that is permitted between wet blasting and immersion in the plating solution if oxidation is to be prevented, and the difficulty of treating intricate parts. Also, the silica deposited in the plating bath may have an effect after a period of time.

The material used for the wet-blasting operation is silicon dioxide—a material which is hard and (of importance to the process) chemically inert, so that it does not contaminate the plating bath. In the wet-blasting operation the hard crystals of silicon knock the oxide from the aluminum surface and at the same time create myriad microscopic hills and valleys on the aluminum surface. The result is that the surface area of aluminum is multiplied about ten times and this adds to the bonding action between the plated coating and the base metal.

A special high-speed plating solution used with the new process permits a chromium deposit of 0.007 to 0.008 in. per hr on the aluminum base. The coatings deposited have a hardness of between 75 and 82 Rockwell C. The costs of plating in this manner are no more, and usually somewhat less, than standard methods of chromium plating steel.

## Fire Control

THE importance of fire as an offensive military weapon cannot be overemphasized, it was stated by Edward J. Kehoe in a talk which he gave at the New York University Conference on Current Problems of Industrial and Institutional Plant Protection. Mr. Kehoe, a member of ASME, is chief, Fire and Accident Branch, New York Operations Office, U. S. Atomic Energy Commission.

For example, he said, in World War II structural damage caused by fire accounted for 80 per cent of the total damage to the cities attacked by air-borne weapons. Actually, 54 German cities and 67 Japanese cities (including Hiroshima and Nagasaki) were "knocked out" by fire.

From the viewpoint of defense, he said, we are confronted with many fires burning simultaneously over a large area regardless of whether the attack is a saturation raid with incendiaries or an atomic-bomb explosion. (It is obvious that whereas relatively few planes are necessary to deliver an atomic weapon, a large air armada is necessary to carry out a saturation-type incendiary raid.) The problem that is presented concerning plant protection is new only in the sense that so many of the fires start simultaneously. Actually, the basic principles of good modern fire-protection engineering are equally adaptable to wartime as they are to peacetime.

Fire-protection engineering is divided into three elements, namely, fire prevention, fire control, and fire extinguishment. In peacetime industrial-plant protection, fire prevention, which prevents the fires from starting, and fire extinguishment, which puts them out, are both very important; however, they are not as important as the factor of fire control. This simply means, in designing the plant, to build-in such fire protection that a fire which starts as a result of a breakdown in fire prevention (and no fire-prevention program is perfect) cannot result in large-scale or complete destruction of the plant. It is invariably a breakdown in fire control which makes possible "large-loss fires," those exceeding $250,000 in destruction, each of which contributes so heavily to the national fire loss.

It is good practice in peacetime to have a plant fire-protection organization. It is absolutely necessary to have one for wartime defense.

An extremely important contribution to fire extinguishment is the "fire-guard" function, Mr. Kehoe said. The air-raid

warden is generally concerned with the protection of personnel in his assigned area, for example, evacuating survivors, assisting the injured, rescuing those trapped. The auxiliary fireman performs his duty by standing by in the fire station and responding with municipal fire apparatus to the large-scale fires. The fire guard is assigned to a specific area (and not to a fire station) and it is his function to extinguish the smaller fires so that the municipal fire unit need not be called. In England, during the war, the fire guards repeatedly saved important plants at times when the regular fire-fighting forces were busy elsewhere. In one attack on Hamburg, 1318 four-pound incendiary bombs which dropped on houses were counted. Of these, 34 per cent were disposed of by fire guards. In the larger industrial plant, fire guards would not necessarily be members of the plant fire brigade which would respond to the larger fires; they would remain in their own departments to handle the incipient fires. Employees must be trained to fight small fires. The more individuals who know how to use a pump tank, extinguishers, or other small fire-fighting equipment, the better. None of the effort expended in training people in first-aid fire fighting is wasted since it is useful in peacetime.

Water remains the only effective tool for the fighting of large fires. There are many efficient agents for extinguishing small fires, but none of them, as effective as they are on incipient fires, can control a tremendous fire. It is surprising how widespread is the disastrously mistaken view that dependence for large-scale fire fighting in wartime must be placed on chemicals because of possible or probable disruption of water supply. It is true that many sources of water supply, such as a municipal gridiron system, may be disrupted in whole or in part by an air-borne attack and cannot be blindly depended upon. However, a goal of good modern industrial fire protection is that a plant have available on its property or in the immediate vicinity a sufficient quantity of water to handle the largest fire that can be anticipated without depending on water mains coming in from a distance. This is a sound objective because water supply is occasionally shut off even during peacetime. The important point is that if this policy is followed for peacetime, the water is available at the plant in wartime, regardless of what happens to the outside water mains.

Considering fire control, buildings of fire-resistive construction (reinforced concrete or protected steel frame) will offer maximum resistance. (It is of interest to note that only 2.3 per cent by number of the buildings in New York are of fire-resistive construction.) Plant management should utilize all of the standard fire-control devices. Fire-resistive construction should be the goal, especially in new construction. Large fire areas representing an unreasonable fire risk should be reduced by standard fire walls. Wider use should be made of automatic sprinkler protection and existing sprinklers should be kept in service and properly maintained. Full utilization should be made of fire detection and alarm systems and all other standard protection practices, such as water curtains to protect against exposures. Protection of records warrants special consideration.

Automatic sprinkler systems can generally be expected to give a good account of themselves, especially if a gravity tank provides the primary supply and is augmented by a reliable secondary supply such as tanks from which water may be taken by a gasoline or Diesel-powered fire pump. A standard gravity tank is designed to resist tremendous wind loads and is probably no more susceptible to blast damage than the building it protects.

It is obvious, Mr. Kehoe said, that there would be no point in attempting complete protection against the possibility of a plant being within the area of complete destruction. However, considering the industrial plant which is located within a congested area easily recognizable as a target, the probability of being in the area of partial damage is far higher than that of being in the area of total damage. Consequently, such a plant should bring its fire protection up to high standards.

All of the features mentioned as being effective in resisting air-borne fire attacks constitute good plant fire protection according to peacetime standards. Well-organized and trained plant fire brigades, fire-resistive construction, water storage at or near the plant, automatic sprinklers, fire walls, detection and alarm systems—none of these factors are new. These carefully engineered fire controls have been used as standards by fire insurance companies and national fire organizations for many years.

Mr. Kehoe indicated, however, that it is in new construction that maximum fire protection can be achieved through careful selection of plant location and good fire-protection engineering. The use of space, which is fundamental in fire protection, is also the most important defense measure against the weapons of modern war. The Department of Defense has stated that "the attractiveness of newly built plants as targets may be reduced. A plant may be located in a city of 50,000 population or less or sufficiently removed to the outskirts of an industrial city so as to make it a less remunerative target. If removed to the city outskirts possible damage to the plant would be reduced in comparison with that if located in close proximity to other plants forming a more profitable target group."

# Cloud Seeding

WEATHER scientist Dr. Vincent J. Schaefer, of the General Electric Company, said recently that ordinary rock salt, used as a cloud-seeding agent, may prove an effective tool in man's attempts to control the fall of rain.

Speaking before a meeting of the American Physical Society in Schenectady, N. Y., recently, Dr. Schaefer said that rock salt or sodium chloride might be used to prevent rain along certain normally rainy coastal regions and enable cloud moisture to be transported to areas further inland before falling as rain.

He said that any coastal region where air is being blown in from sea should be suitable for testing salt seeding and mentioned as possibilities certain areas of the California coast, the Olympic Peninsula in the Northwest, and coastal areas of Puerto Rico and Hawaii.

Unlike seeding materials, such as silver iodide and dry ice, which are effective only in clouds of below-freezing temperature, the rock salt as a seeding agent would be used in clouds of above-freezing temperature, he said.

It is from this type of cloud that much of the rainfall in these coastal areas comes, he added.

According to the G-E scientist, certain salts, in fine-particle form, have an ability to attract and collect the tiny molecules of water vapor which are present both in clouds and in open air, and in collecting them, can virtually "grow" tiny raindrops heavy enough to fall. These raindrops similarly can "sweep up" or collect droplets in their path, resulting in full-fledged raindrops and general rainfall.

It is believed that nature uses these salts in such fashion to produce much of the consistent rains in coastal areas, since clouds and air blown in from the sea contain salt particles.

Dr. Schaefer pointed out, however, that in order to produce rain, an optimum or ideal number of salt particles in relation to the amount of moisture available must be present. It is somewhat evident, he said, that along coastal regions, nature is often providing these optimum numbers, since rain falls with considerable consistency there.

The weather scientist said that one way to unbalance this ideal number of salt particles present would be to add great

quantities of tiny rock-salt crystals in a technique called "overseeding." By overseeding, less moisture would be available per salt particle, which would, in effect, stunt the growth of potential raindrops sufficiently to prevent their becoming heavy enough to fall.

As the mass of air and clouds moves further inland, however, it would gain more moisture on the way which eventually would be sufficient to strike an ideal balance again with the salt particles and thus initiate rainfall.

Dr. Schaefer said he believes the success of this overseeding technique will depend upon using rock-salt crystals in a certain critical particle size. Particles too big or too small will not work efficiently and may not work at all, he said.

He explained that rock salt could be dispensed from the ground into the atmosphere by special coke-burning generators, which would first vaporize the salt, then project it out at high velocity, which would cause it to cool quickly in the form of fine solid particles.

Too light in weight to fall, these particles would be carried into the atmosphere by upward wind currents, he said.

# Speed-Altitude Record

THE Navy's sonic research plane, the Douglas Skyrocket, has attained the highest speed and altitude recorded by a piloted airplane, the Navy announced recently.

The plane reached a speed of 1000 mph in its climb, and while the exact altitude figure was not released, the Navy revealed that it exceeded the world's record of 72,394 ft about (13.7 miles).

Accomplished under rocket power after being carried aloft by a B-29 mother ship, the Skyrocket's history-making tests were flown at Edwards Air Force Base, Muroc, Calif.

Air launching of the supersonic research craft, designated D-558-2, continues a program of high-speed investigation initiated by the Navy and Douglas Aircraft Company, Inc., in co-operation with the National Advisory Committee for Aeronautics and similar programs conducted by the U. S. Air Force. The entire national sonic research program is pointed toward extending aeronautical knowledge in realms far beyond the speed of sound.

The sweptwinged Skyrocket first flew in early 1948 with combined jet and rocket engines which permitted it to take off and land as a conventional airplane. Subsequently, it was flown repeatedly through the speed of sound to demonstrate the routine practicality of supersonic flying and to obtain urgently needed aeronautical data.

An extension of the Skyrocket's speed researches, beyond the program's original requirements, was decided upon in November, 1949. Douglas was assigned to continue the program by launching the exploratory craft from a mother ship.

It had become evident that the Skyrocket was capable of far greater speeds than were possible by taking off from the ground and climbing to moderate altitude using both jet and rocket engines.

To attain the highest speeds consistent with fuel capacity, it was required that the airplane operate in the upper atmosphere where the air is thinner and offers less resistance, and where it is difficult to operate jet engines.

It was necessary that the Skyrocket be carried as high as possible by a mother ship before employing its own power. Longer performance of the rocket engines was required to accelerate the ship into the advanced high-speed regions.

The Skyrocket is normally powered by both jet and rocket engines. In recent flights, however, the jet engine was eliminated and fuel added in its place to double rocket flight duration. A ton of propellant each minute is thrust through the craft's rocket tubes.

# Variable Wing Sweepback

THE first aircraft to feature wings whose degree of sweepback can be varied in flight will begin flight tests at Edwards Air Force Base at Muroc, Calif., according to the CADO *Technical Data Digest*, August, 1951. It is the Bell X-5, a jet-propelled ship produced after three years of research by the Air Force, the National Advisory Committee for Aeronautics, and Bell Aircraft Corporation engineers.

The concept of variable wing sweepback to reduce compressibility at sonic speeds has been considered by aeronautical engineers for 10 years. As a flying laboratory of the NACA, the X-5 gives opportunity to investigate aerodynamic effects of changing the degree of sweepback during flight. The X-5 is expected to have all the advantages of conventional planes in take-off, climb, maneuvering, and endurance, plus very high speeds.

Viewed in profile, the X-5 has a "flying guppy" configuration which results from mounting the Allison J-35-A-17 turbojet engine under the cockpit rather than behind the pilot. Its power plant extends through the second and third quarter of the ship's length, the tail pipe protruding beneath the fuselage and not from the rear of the plane.

The X-5 is 33 ft 4 in. long and 12 ft from ground to fin tip. Wing span is 32 ft 9 in. and weight is approximately 10,000 lb. A slender, spearlike boom, extending an additional eight feet from the nose, houses yaw-measuring devices and a Pitot tube used in registering indicated air speed.

The needle-nosed X-5 is enameled white. It is felt that white will afford the greatest visibility when the plane is

FIG. 4 DOUGLAS SKYROCKET BEING CARRIED ALOFT BY ITS MOTHER SHIP, A NAVY B-29

visually tracked through cloudless skies high above the Muroc dry lake bed. Tracking by radar will also be done.

A major development was the achievement by Bell engineers of a mechanism for changing wing sweepback in flight, while simultaneously compensating for the resulting shift of the center of gravity. Each wing has a specially designed fairing to insure that its leading edge presents a smooth airfoil regardless of sweepback angle. The leading edges of the wings are fitted with slats which comprise an integral part of their upper surface when not extended. When extended they increase aerodynamic lift, appreciably reducing stalling speed.

Two dive brakes are located in the sides of the fuselage forward of the cockpit. They are metal "doors" which can be opened hydraulically until they are at nearly right angles to the fuselage. Protruding, they provide rapid deceleration.

The axial-flow turbojet engine develops a 4900-lb thrust. Its air-inlet duct extends straight from the nose to the front of the engine. This design holds air-duct loss to a minimum, scooping greater quantities of air at altitudes where decreased oxygen lowers jet-engine performance. The cockpit of the X-5 is a few feet behind the nose. Its sliding Plexiglas canopy, with only a slight blister, conforms almost perfectly with the smooth contour of the fuselage. Visibility is said to be excellent.

The cockpit is pressurized and air-conditioned to maintain safe and comfortable conditions for the pilot at high altitudes. Both the cockpit canopy and the seat are jettisonable for emergency escape. Ejection is accomplished by exploding a cartridge, hurling the pilot 50 ft above the ship and clear of the tail fin for parachute descent.

## Transonic-Supersonic Tunnels

A NEW prototype wind tunnel, to be used for high-speed aerodynamic instruction and research, has been completed at the Aeronautical Laboratory of the U. S. Naval Postgraduate School, Annapolis, Md.

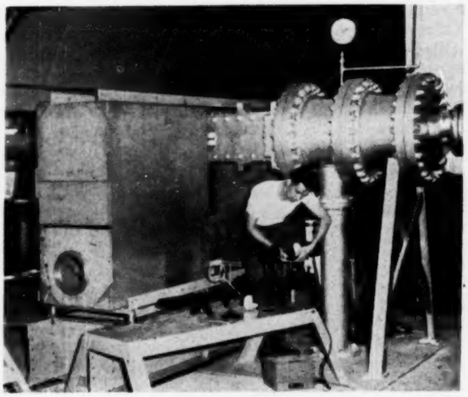
Ceremonies marking the official opening of the Transonic-Supersonic Wind Tunnels were held on July 17, with the guest of honor and principal speaker being Rear Admiral Calvin M. Bolster, USN, chief of Naval Research. Following the dedication address in the auditorium of the Postgraduate School, Professors W. M. Coates and R. M. Head of the Postgraduate School staff, conducted technical discussions on the wind tunnel and a tour of the new unit for the guests, which included eminent scientists and educators from all over the country, and ranking officers of the Armed Forces.

The new Transonic-Supersonic Wind Tunnels were designed by the Naval Advisory Committee for Aeronautics for the Office of Naval Research, and developed for the national program supporting educational institutions under the Unitary Plan.

Capable of producing air speeds up to 2500 mph, the tunnels were originally assembled at the Langley Memorial Laboratory where they were given preliminary performance tests. Following their tests at the Langley Laboratory, they were disassembled and shipped to Annapolis where they have been set up in the North Severn Aeronautical Laboratory of the Postgraduate School.

The two wind tunnels constitute a unit made up of a transonic induction-type tunnel with a 4 × 16-in. test section, and a supersonic blowdown-type tunnel with a 4 × 4-in. test section. The latter is capable of air speeds from about 1000 to 2500 mph, while the former can give air speeds both below and slightly above that of sound, or about 250 to 1000 mph.

Air is pumped by a 175-hp compressor through a drier into a storage tank. This tank has a capacity of 2000 cu ft, at a maximum pressure of 300 psi. It provides the air for the intermittent operation of either one of the tunnels for test periods ranging from one to six minutes.



*Official Photograph—U. S. Navy*

FIG. 5 NEW TRANSONIC-SUPERSONIC WIND TUNNELS AT ANNAPOLIS

(Finishing touches are put on the interferometer of the U. S. Naval Postgraduate School's new transonic wind tunnel.)

Instrumentation associated with the wind tunnels has been procured with the co-operation of several technical branches of the Navy. An important item in the Supersonic Tunnel is an interferometer of the Mach-Zehnder type, built by the Naval Gun Factory from Naval Ordnance Laboratory designs under the sponsorship of the Office of Naval Research. The interferometer is an optional instrument which measures variation in density of the air in a section of the tunnel, consequently measuring the variation of pressure and velocity of the air. In the transonic tunnel, another type of optical instrument provides schlieren projection.

## Seaplane Beaching Gear

MODEL tests carried on at the Experimental Towing Tank at Stevens Institute of Technology, Hoboken, N. J., were instrumental in the development of a seaplane beaching gear which can submerge itself, move backward, forward, and sideways, or crawl out of the water onto sandy beaches on its own power-driven tread with a 300,000-lb flying boat on its back. The beaching gear has been designed and developed for the United States Navy by the Edo Corporation, College Point, L. I., N. Y. The development is the result of research on simplifying the handling of large flying boats, such as the Consolidated P5Y turboprop-powered flying boat, whose range, speed, and general performance have opened new commercial and naval possibilities for water-borne aircraft but which up to now have presented tremendous problems in launching and beaching.

What was needed was a beaching gear which would be effective without specially prepared ramps, without special beaching-gear structure in the plane, and which would require a minimum of time and manpower for operation.

Developed with these points in mind, the new bleaching gear, designated as the Model 144, looks very much like the floating docks used to handle large ships. The model consists of two vertical flotation units spaced far enough apart to accommodate the hull of a flying boat. Separating these two units is a horizontal platform on which is located a removable pallet

with adjustable pillows on which the vee-bottomed hull rests.

The gear is propelled by two engines driving two propellers at diagonally opposite ends of the floats. These propellers can be rotated through 360 deg which permits the operator of the dock to proceed in any direction or turn it on its own axis. Two control stations are provided, either of which will operate the entire unit without the other.

Details of the beaching gear's operation and its method of picking up a flying boat have been worked out by the use of a large operating scale model. In picking up a flying boat, the beaching gear is partially submerged by flooding parts of the floats. In this condition the gear is brought up from astern of the flying boat until it is positioned under the main part of the hull.

To prevent damage to the flying boat or beaching gear during the contact operation, pneumatic bumpers are installed at all contact points. Four sloping guide pads keep the hull centered between the floats while two large low-pressure pneumatic cushions are raised up from each float to bear on the underside of the wings. These prevent relative motion between the beaching gear and the flying-boat hull while the flooded compartments are pumped out to let the boat rest securely on the pallet.

The beaching gear then proceeds toward shore under its own power. As the shore is approached the operator of the beaching gear transfers his power from the propellers to three caterpillar treads mounted in tricycle-gear fashion and capable of operating over normal sand beaches.

On dry ground the gear proceeds to unloading platforms, already provided, to which the pallet and the flying boat can be transferred. This is accomplished quite simply by using a tractor or winch to move the pallet, which has wheels, from the gear to the platform.

Thus relieved of its load the beaching gear is quickly ready to proceed into the water to retrieve other flying boats.

Provisions for handling repairs and general servicing have been incorporated in both the beaching gear and the pallet. The pads of the pallet, on which the hull rests, are segmented and quickly adjustable by means of screw jacks to fit the contour of any hull. Several of these pads may be dropped at one time to allow access to the bottom to repair damage.

Development of the project has reached the stage where a one-tenth-size scale model has been completed and tried under many exhaustive tests. Tests have included many simulated contacts with a one-tenth-size model of a P5Y flying boat.

# Recoilless Rifles

AMONG the new weapons for infantry units are recoilless rifles, developed at Frankford Arsenal, Philadelphia, Pa., which are effective antitank weapons, and are accurate enough to wipe out a machine-gun position or enemy personnel at 800 to 1000 yd. These new weapons, according to the *Industrial Bulletin* of Arthur D. Little, Inc., also put even more defense emphasis on industrial production, for they usually become additions to existing armament, rather than replacements for older weapons. Thus an infantry division now uses 1120 recoilless rifles, in addition to its more conventional equipment.

The 57-mm recoilless rifle, including its sight, weighs only 44 lb, as compared with about 1000 for an artillery piece of equivalent performance, and it can be carried by one or two men. Weight is saved by eliminating the conventional recoil-absorbing mechanism and heavy mounting, and lighter-barrel design is usually possible. The recoilless rifle is supported by a light tripod, or can actually be held and fired from the shoulder.

Recoil is avoided by placing in the gun's breech properly sized and shaped holes or nozzles through which escape some of the gases generated by the explosion of the propelling powder. The momentum of this backward-moving gas balances the momentum of the forward-moving shell, just as the momentum of the kicked-back gun balances the shell's momentum in a conventional artillery piece. The escape ports are designed to eject the gas at high speed, giving a relatively small weight of gas the required momentum. Even so, the recoilless rifle requires substantially more propellant than does the standard comparable artillery weapon. So accurately are the escape holes designed and made, even on a mass-production scale, that the "kick" is only about $^1/_{16}$ that of an ordinary shoulder rifle, although close to 200,000 hp are generated within the weapon for about 0.007 sec. As the gun wears out and the holes in the breech increase in diameter, the weapon may develop some forward kick.

So effective are the recoilless rifles that, although they were first tried out on a limited scale in the Philippines in World War II, an infantry division now has almost as many of them as mortars, the *Bulletin* states. While the back-blast of the escaping gases may give away the weapon's position, its lightweight and mobility permit moving it after every one or two shells are fired. With greater fire power within the infantry unit, and the necessity for free movement, the order of battle has been somewhat changed. A more open dispersal of personnel and weapons is necessary to avoid concentrating men to draw enemy fire, and this becomes possible with accurate long-range weapons. With the men more scattered, command units must be smaller, and there is need for more sergeants and corporals. The enormous fire power available to an infantry unit and the need for scattering also make heavy demands on intelligence, initiative, and training, and a longer training period may be necessary.

# Instrument Contacts

A REVIEW of the theory of electric instrument contacts as applied to the field of low-current low-pressure contacts and low-current sliding contacts, was given by Erle I. Shobert, 2nd, technical director, contacts and nonferrous metallurgy, Stackpole Carbon Company, St. Marys, Pa., during the joint 1950 ASME Industrial Instruments and Regulators Division—Instrument Society of America Conference held in Buffalo, N. Y. The purpose of the review is to point out the physical phenomena which play important parts in the operation of such contacts, and thus give engineers and technicians some tools with which to work.

The various aspects of contact operation which are discussed in detail include hardness, contact resistance, contact temperatures, oxidation and surface films, material transfer, wear in the arc, sliding contacts, and lubrication.

Since most instrument contact applications have available only light forces, low currents, and relatively low voltages, the most important consideration is the surety of making and breaking a circuit. Any materials which form insulating or high-resistance films in air cannot usually be used, except for sliding contacts, plug contacts, or in cases where sufficient forces are available to break through the film.

This leads, therefore, to the consideration primarily of silver and the noble metals and their alloys. Silver is of course the most important contact material and it is used in many cases. Here again it is necessary to be able to break through the sulphide film either mechanically or electrically if silver can be used satisfactorily in air.

The other materials which come into consideration are gold and its alloys with silver, copper and nickel, platinum and its

alloys with silver, iridium, palladium, ruthenium and tungsten, and palladium and its alloys with silver, and other metals. Of these metals, only platinum and some of its alloys will form considerably high-resistance films under ordinary conditions. Pure gold is the best from the standpoint of film formation under atmospheric conditions. It is somewhat softer than many of the other alloys and its use is somewhat limited by this characteristic.

When certain contact problems arise or can be anticipated on a particular relay or instrument, it is necessary to analyze the difficulty in the light of the physical processes which may be contributing to the problem. It is then necessary to choose contact materials which are less subject to these difficulties or to make changes in the device which will eliminate some of the causes of the trouble.

Much of the information presented in Mr. Shobert's paper is covered in detail in the book, "Electric Contacts," by R. Holm, H. Geber's Förlag, Stockholm, Sweden, (in English), and is continually referred to in the paper.

# Harbor Radar System

A SUCCESSFUL test of harbor radar was unveiled recently by the Raytheon Manufacturing Company, Waltham, Mass., which, unlike other harbor radar installations, which merely use land based ship radar equipment, uses a completely new approach to the problem.

Tests were conducted in Boston Harbor on Deer Island during July under actual conditions encountered in a busy harbor.

FIG. 6 WORLD'S LARGEST COMMERCIAL RADAR ANTENNA

(This huge scanner, 41 ft wide, is the "eyes" of the harbor radar system built by Raytheon Manufacturing Company for the Port of Le Havre, France. It is shown in position for tests at Deer Island, at the entrance to Boston Harbor. Antenna can operate in winds up to 100 mph.)

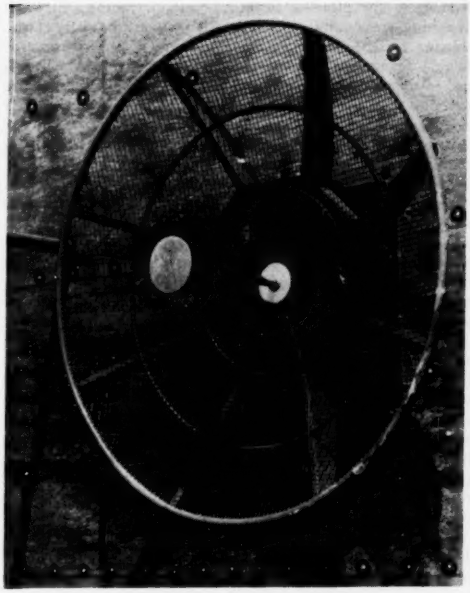


FIG. 7 MICROWAVE LINK ANTENNA

(Shown in position at Deer Island installation is antenna of microwave link used to transmit radar information from island to receiving station at Commonwealth Pier, South Boston, which served as harbor radar center for test and demonstration by Raytheon Manufacturing Company and Port of Boston Authority.)

Vessels were moved in and out of the harbor under conditions simulating zero-zero visibility. Orders were given to the vessel's pilot by means of two-way radio-telephone equipment.

The system employs the world's largest commercial-type antenna. It is 41 ft wide and weighs approximately 10,000 lb. This large antenna produces a beam width of only 42 min and has a power gain of approximately 10,000.

Since harbor radar equipment is normally installed ashore, the usual shipboard indicator would not be satisfactory because of the enormous wastage of PPI tube space due to land masses, according to Raytheon. In order to eliminate this, the company has developed an adjustable offset-type indicator whereby the land masses can be moved off the screen and the radar station put on the edge of the screen. This has the effect of doubling the usable tube diameter thereby providing greater magnification of objects viewed. The indicator used on the harbor radar system employs 16-in. tubes. Thus by offsetting and eliminating unwanted objects the presentation is the same as would be seen on a 32-in. tube. In the harbor radar system tested at Deer Island, one standard indicator and three offset indicators were employed. The three offset indicators were offset in three different directions thereby producing expanded pictures out toward the sea, in the channel between Deer Island and Long Island, and in the direction of the piers and docks of Boston Harbor. The standard indicator was used to check all directions simultaneously.

In order to keep track of all vessels anchored and moving in and out of the harbor, the newly developed Raytheon reflection plotter was employed.

This device, which employs a semimirror, projects a pencil

mark from the plotting surface directly onto the PPI tube. By taking fixes on objects at intervals and marking them on the plotting surface, the direction and speed of a vessel can be quickly determined and dangerous situations avoided. This is said to be many times faster and safer than the indirect plotting methods used heretofore. Only one person is involved and plots are made directly on the radar image. Plots made on the plotting surface which is permanent can be quickly erased; thus no replacement is required.

During the Deer Island tests, a method of transmitting radar information directly to remote points was tried for the first time. This method employs a microwave relay link to transmit bearing, trigger, and video information to a remote point, which in this case was Boston's Commonwealth Pier. At Commonwealth Pier a microwave receiver was installed along with the terminal equipment and a standard 16-in. radar repeater indicator.

The radar repeater faithfully reproduced the picture as seen at Deer Island on any of the six independent ranges included in the equipment. This first transmission of radar information by microwave demonstrates the practicability of tying together a chain of harbor radar stations that would be required in a very complicated harbor, the Company said. As a matter of fact, this demonstration shows that radar information could be transmitted great distances either by microwave or by coaxial cable similar to the method now employed to transmit network television programs.

The first harbor radar system will be installed in the Port of Le Havre, France. One other engineering model is undergoing tests at the Port of New York and plans are under way to make a number of installations in other major world ports over the next two years.

## Electric Power Survey

THE Ninth Semi-Annual Electric Power Survey by the Edison Electric Institute, as reviewed in *Combustion*, July, 1951, points out that from a total electric energy output of approximately 277 billion kwhr back in 1948, a figure of 408 billion for 1952 is indicated, with slightly over 325 billion estimated for the current year.

Peak, capability estimates are as follows: 1951, 74,498,000 kw; 1952, 84,152,000 kw; 1953, 94,763,000 kw; and 1954, 100,581,000 kw.

While the program for increasing capabilities for this and next year is based on the maximum to be expected from the standpoints of new equipment and the time required for plant construction, it is recognized that load during this period may increase faster than new capacity can be brought into service.

Reserve margins for the whole country, which represent additional capability available at the peak period to cover maintenance, emergency outages, operating requirements, and unforeseen loads, range from 8.5 per cent in 1951 to an anticipated figure of 16.1 per cent in 1953. Of course these are averages and the percentages vary for different regions. For example, the 1951 percentages are given as South Central 23.4, West Central 20.9, Southwest 18.9, North Central 9.8, East Central 8.8, Northeast 8.6, Southeast —1.1, and Northwest —3.2 per cent. Since these are expressed in per cent of peak capability, the figures do not represent relative marginal capacities.

For the seven-year period, 1948 through 1954, builders of large steam-turbine-generators (10,000 kw and above) show a total of shipments and scheduled shipments exceeding 40 million kw, of which 91.1 per cent applies to utilities in the United States, 4.7 per cent to industrials, and 4.2 per cent to export. The total for small steam-turbine-generators is 2,589,700 kw and for the water-wheel generators 9,626,100 kw. The corresponding figure for capacity of steam-generating units is 434,476,000 lb per hr of which nearly 75 per cent applies to U. S. utilities, 15 per cent to U. S. industrial plants, and 10 per cent to export. The large turbine-generator figure for 1951 is 6,474,500 kw, of which 5,124,500 represents utilities in this country. The largest shipments will be in 1952 when nearly $9^1/_2$ million kw of large units will be turned out by the turbine manufacturers.

On the other hand, 1951 represents the high for manufacturers of steam-generating equipment with 99,856,000 lb per hr capacity, shipped, on order, or scheduled for shipment.

## Taxes, Jobs, Dividends

THE National City Bank of New York, in one of its recent "Monthly Letters on Economic Conditions and Government Finance," points out that the program now before Congress calling for the third stiff increase in corporate income taxes makes timely an examination of the wealth of information on the taxes already being paid by corporations, as given in their annual reports for 1950. The figures of the large companies serve as good illustrations, the Letter states, because they are given promptly and in detail, and because the companies themselves are known to such vast numbers of customers, employees, and investors.

For example, for the 100 largest companies combined, the reported total assets, including plant and equipment, plus current assets of cash, government securities, receivables, and inventories, aggregated \$85 billion at the year-end. This represented an average of over \$16,600 per employee. For the major divisions of business, the average investment per job ranged from about \$7000 for trade and \$14,000 for manufacturing, up to \$22,000 for railroads, and \$53,000 for electric and gas utilities.

According to the Letter, these 100 companies furnished employment last year to a total of approximately 5,100,000 men and women. Largest employers are the Bell Telephone System with 602,000, General Motors 465,000, U. S. Steel 288,000, General Electric 184,000, Bethlehem Steel 136,000, Pennsylvania Railroad 125,000, Chrysler Corporation 117,000, Sears Roebuck 117,000, Standard Oil (N. J.) 116,000, and New York Central 111,000.

Payroll figures, reported by 83 companies in the group, showed an average annual compensation of about \$3750 per employee—including in many cases the cost of pensions, hospital insurance, and other employee benefits. Based upon this average for companies representing 89 per cent of the total employment of the group, the total payroll may be estimated around \$19 billion. For every \$100 paid in wages and salaries, \$65 was paid in taxes.

These 100 largest corporations are owned by a total of 7,200,000 registered shareholders. Such an army of "capitalists" would fill 390 areas each the size of Madison Square Garden in New York. While the total number of registered shareholders contains, on the one hand, duplications to the extent that some people own stock in more than one of these companies, it does not show, on the other hand, the large number of beneficial owners whose stock is registered in the name of a single bank, broker, insurance company, investment trust, or nominee.

The AT&T System had 990,000 shareholders at the year-end and in May welcomed the 1,000,000th—the only corporation in history to be owned by so many partners. More than 200,000, or one third, of its own employees are shareholders also. Other companies with long shareholder lists are General Motors with 446,000, U. S. Steel 257,000, General Electric

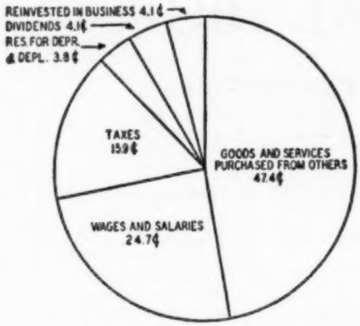



FIG. 8 DISPOSITION OF INCOME, IN CENTS PER DOLLAR OF THE 100 LARGEST NONFINANCIAL CORPORATIONS IN 1950

250,000, Standard Oil (N. J.) 222,000, Cities Service 217,000, Pennsylvania Railroad 190,000, Pacific Gas & Electric 170,000, Socony-Vacuum Oil 158,000, and Consolidated Edison 150,000.

Preferred and common shareholders of the 100 largest companies received dividends of $3.1 billion last year—representing an average of about 4.1 cents per sales dollar. An equal share of net income was reinvested in the business to finance improvements and expansion of plant and equipment and to build up working capital.

Total taxes of these companies last year were equal to $13.41 per share of common stock outstanding. Taxes were 3.9 times as large as dividends, while total direct labor costs were 6.0 times as large as dividends. Both dividends and payrolls were, of course, subject to additional taxes paid by the recipients.

## Atomic Energy Report

THE Tenth Semiannual Report of the Atomic Energy Commission was recently released and reveals that the AEC has increased its supplies of raw materials and its output of fissionable materials during the first six months of 1951 while pushing ahead with a very large expansion of production capacity. New foreign sources of uranium ores were being tapped; increases in supplies and processing placed the United States second among the free nations in the production of uranium. Two series of weapons tests were carried out.

Construction and equipment accounted for nearly three fourths of the more than $2 billion appropriated for fiscal year 1951. Work progressed at the two new major production plants in South Carolina and Kentucky. Construction of a number of other facilities proceeded at an accelerated pace.

In January and February, near Las Vegas, Nev., the AEC conducted the first nuclear weapons tests in the continental United States since the original atomic bomb was fired at Alamogordo, N. Mex., in July, 1945. Additional tests were held at Eniwetok Atoll in April and May.

Work on nuclear reactors to power submarines made progress during the last six months, according to the report. Development of reactors to propel military aircraft also advanced. An experimental "breeder" reactor, designed to get basic information which might be used to increase rates of fissionable-material production was nearing completion at the National Reactor Testing Station in Idaho. Agreements were signed with four industrial groups for studies on the possibility of private investment in building and operating dual-purpose reactors to produce fissionable material and electric power.

A major part of research in the physical and life sciences was directed toward finding solutions of immediate developmental and health and safety problems, but AEC continued commensurate efforts to broaden the base of our knowledge as a foundation for the future progress on which national security ultimately depends.

Expanded atomic-energy activities are encountering problems which arise from the simultaneous large increase in other defense work or are directly related to establishing new operations sites and field offices, the report stated.

Continued co-operative action with the National Production Authority enabled AEC substantially to meet its scheduled requirements for supplies and materials through use of Defense Order priorities. Operations under the priorities system were assisted by (1) expansion of original NPA delegations of authority to AEC to provide assistance to privately financed programs that supply AEC and (2) co-operation of NPA in providing special assistance in obtaining deliveries.

Under the Controlled Materials Plan effective on July 1, 1951, AEC was designated as both a claiming and allotting agency. Analyses of requirements for materials and equipment indicate that AEC's needs for such basic materials as steel, copper, and aluminum are not great enough at the present time to have a serious impact on national supply.

## Metals Production

LATEST figures collected by the Bureau of Mines show an upward trend in domestic production of most of the strategic and critical metals and minerals. For example, more copper was mined in this country during May than in any previous month since June, 1944.

The principal factor in this trend has been a sharp upswing in the average price of metals and minerals. Another has been a feeling on the part of industry that defense mobilization will provide a sustained market.

Compared with the average monthly production rates for the first quarter of 1950, May saw the output of copper up 18 per cent, of zinc up 23 per cent, and of sulphur up 6 per cent. Because of the seasonal nature of iron-ore and cement production, figures on them are misleading, but the adjusted trend of production of these two commodities also is upward. In fact, lead is the only mineral on which the Bureau collects monthly data, production of which was lower during May than the monthly average for the first quarter of 1950— a decline of 6 per cent, which is partly attributable to a labor dispute.

Comparison of the first quarter of 1951 with the corresponding quarter of 1950, shows fluorspar production up 44 per cent, molybdenum up 66 per cent, tungsten up 60 per cent, and manganese up 1 per cent. Mercury production is down 48 per cent.

The nature of mine operation is such that the direct effect of most of the programs of the Defense Minerals Administration inevitably will not be felt for many months. Extended preparatory work almost always must precede new production. Ore bodies must be blocked out, shafts and other means of entry completed, and usually mills constructed, before work can begin.

It will be some time before mines and plants for which the Defense Minerals Administration has recommended accelerated tax amortization will be completed. (MECHANICAL ENGINEERING, September, 1951, page 742.)

One of the important effects of the Defense Minerals Administration program will be the replenishment of mineral reserves for future years. As a result of exploration projects carried on with Government assistance, the balance between production and known reserves, which is being dangerously upset by current heavy demands, may be restored.

# ASME TECHNICAL DIGEST

*Substance in Brief of Papers Presented at ASME Meetings*

## Central-Station Controls

**Modern Methods and Equipment for Control of Steam Generators,** by P. S. Dickey, Mem. ASME, Bailey Meter Company, Cleveland, Ohio. 1951 ASME Semi-Annual Meeting paper No. **51—SA-40** (mimeographed).

HIGHER ratings on major central-station units and auxiliaries, and increased steam pressure and temperature necessitate the use of better and more complete instruments and automatic control for safe and efficient operation.

When we assign responsibility for proper operation of the unit capable of generating 150,000 kw to a smaller supervisory force, we must of necessity give those supervisors every possible informative device, protective device, and automatic controller which will contribute toward safe and economical operation of the unit. Initial cost and upkeep of instruments and automatic control is far less than the present-day cost of the large supervisory force required to take their place. Since cost of fuel and cost of supervision will undoutedly continue to rise, there is every reason to continue the trend toward more complete automatic control.

Studies of supervisory control stations for various control-station generating plants indicate that complete supervision of the larger boiler and turbine units will require 300 or more points of measurement and control per unit. The studies also point to the following general conclusions regarding arrangement of the centralized supervisory control stations:

1 A common control station for two large boiler and turbine units has the advantage of central location, minimum piping and wiring, and good utilization of supervisory manpower.

2 Control panels should be compacted as much as possible to minimize the distance which must be covered by the supervising operator.

3 A functional arrangement of instruments and controls is likely to provide greater operator efficiency and to minimize operating errors.

New types of compacted instrumentation and control will soon be available and this equipment will be useful in the development of more compact and more efficient supervisory stations.

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**Considerations in the Use of Smaller Instruments and Their Relation to Centralized Control,** by T. W. Jenkins, Jun. ASME, Leeds and Northrup Company, Philadelphia, Pa. 1951 ASME Semi-Annual Meeting paper No. **51—SA-46** (mimeographed).

THE devices located on a control panel are primarily for the operator's use and information. In addition, where panel space is not a limiting factor, certain recording instruments may also be mounted on the panel to provide historical data.

These panel-mounted devices may be divided into groups according to their function, as follows:

1 *Operating Devices.* This group will include switches and valves which will be used by the operator for starting, stopping, and regulating apparatus throughout the plant.

2 *Indicating Devices.* This group includes ammeters, position indicators, pressure and draft gages, temperature and level indicators, signal lights, annunciators, etc. These indicating devices are primarily for the operator's guide in manipulating the operating devices.

3 *Recording Devices.* These devices include flow, temperature, level recorders, etc., for (*a*) the operator's use in determining trends, rate of change, and per cent of current conditions with previous conditions, and (*b*) providing historical data for determination of efficiency, trends of abnormal conditions, etc.

In the design of an operating panel, first consideration should be given to providing the operator with the operating devices and information necessary for him to perform his job. Consideration should next be given to locating this equipment on the panel board in a logical arrangement so that the operator may make the most efficient use of these devices. It is desirable to locate operating and indicating devices, such as switches, ammeters, pressure gages, meters, position indicators, etc., pertaining to specific

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apparatus, in a suitable organized group.

Where appreciable panel space is required for each of these groups, the various groups of devices may be spread out over a considerable length of panel board. To reduce the number of operators, or to permit a single operator to remain at one location, certain steps may be taken in the design of the operating of the panel to reduce the panel space required for the operator's use.

To minimize operating panel size, the following approaches are available in designing the panel arrangement: (1) Eliminate the device by eliminating its need, (2) locate device elsewhere, (3) combine devices, particularly those of related quantities, and (4) reduce the size of the panel devices.

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**Remote Operation Through Centralized Control Rooms—A New Concept Developed on the American Gas and Electric System,** by T. T. Frankenberg, Mem. ASME, American Gas and Electric Service Corporation, New York, N. Y. 1951 ASME Semi-Annual Meeting paper No. **51—SA-47** (mimeographed).

SINCE remote operation represents a step beyond the mere centralization of controls, it requires as a minimum a well-laid-out, convenient, and effective control room. For realizing complete remote operation of the steam-generating unit, the following must be done:

First, a survey must be made to cover the various operating situations that may arise, and careful thought given to the ways in which they will be handled. Some items to be considered are: accidental tripping of the generator, loss of vacuum, boiler-tube failure, and loss of ignition.

At the same time, the method of starting, stopping, and of handling major load changes demands attention. This will result in placing each condition with its corrective action into one of the following classifications:

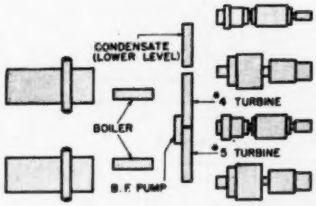
1 Those about which the operator can do nothing, such as a boiler-tube failure.

2 Those in which corrective action can be postponed for some considerable period, such as the partial plugging of a service water strainer, or the closing of certain values during start-up.

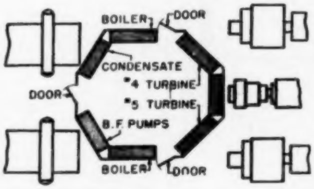
3 Those to which automatic control can be applied, as pulverizer-output temperature control and certain automatic by-passes.

4 Those which require the immediate and intelligently directed efforts of the operator, such as loss of ignition.

Obviously, the conditions in groups




CONVENTIONAL DECENTRALIZED CONTROL PANELS AS ARRANGED IN 1940




POSSIBLE REARRANGEMENT IN LIGHT OF PRESENT EXPERIENCE WITH THE CONCEPT OF CENTRALIZATION

(1) and (2) do not warrant bringing any further items into the centralized control room. Those of group (3) may be supervised or have alternate manual control in the control room. Group (4) is the only one which justifies extra expenditure for remote operating equipment. It will be found necessary to have such equipment as remotely operated oil torches, full control of burner and secondary air dampers, burner television, etc., to cope with loss of ignition. In general, this is expensive equipment. To prevent loss of vacuum following a turbine trip-out, however, it was found that merely providing a small recirculating valve to create flow through the condenser of the steam-jet air-ejector would suffice.

In all of this a somewhat statistical approach is required, with due consideration of the economics involved. Necessary items range from a few hundred to many thousand dollars, but each is important to the final object—trouble-free remote operation.

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**Centralized Control of Steam-Electric Generating Stations,** by Melvin D. Engle, Fellow ASME, and Homer F. Hatfield, Mem. ASME, Pennsylvania Power and Light Company, Allentown, Pa. 1951 ASME Semi-Annual Meeting paper No. **51—SA-42** (mimeographed).

THE use of centralized control in a steam-electric station places the supervisory instruments and controls for the major equipment and auxiliaries in one central location where the station operation can be co-ordinated and supervised by highly skilled operating personnel. This will help to (1) maintain the station efficiency as close to test efficiency as possible, (2) increase station availability because operators can anticipate and correct conditions which could lead to outages, (3) restore service more quickly when trip-outs do occur, and (4) reduce the number of men required to operate the station.

The type of centralized control we are using today is a simple and logical outgrowth of the old ideas and consists of locating the control boards for turbine-generators, steam-generating units, and major auxiliaries closely adjacent to each other.

The development of automatic combustion control equipment for steam-generating units in the 1920's reduced the amount of attention required of the operators and made it even more logical that the supervisory instruments and controls be located close together. The adoption of motor drive for all major auxiliaries also helped. The development of outdoor stations for all climates adds impetus to the increased use of centralized control.

Regarding the completeness of centralized control, it seems logical that the ultimate aim should be to centralize the supervisory instruments and controls for the entire station in a very few control rooms.

It also appears to be important that major supervisory instruments and controls should be provided with recording charts to give the control-room operators a past record rather than merely an instantaneous reading. Recording instruments will also minimize the need for log sheets. This will leave the operators free to exercise the operating judgment which is needed beyond the ability of automatic controls.

Pilot lights and alarms should be provided to inform the operator of noncontinuous operations and abnormal conditions which require the exercise of his operating judgment.

Important instruments and gages should be of adequate size and conveniently located to permit the operators to see them without too much effort.

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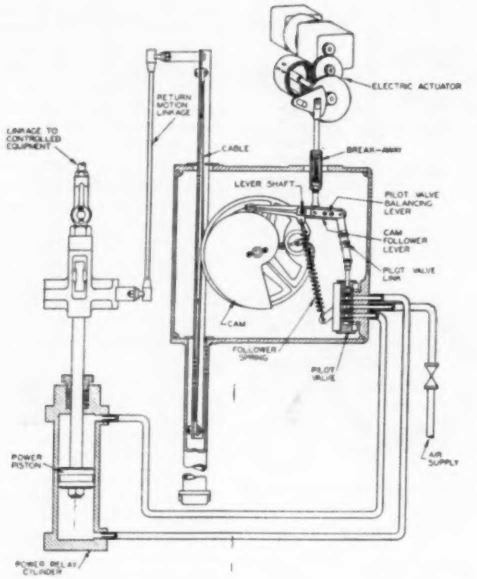
**Electronic Combustion Control,** by Charles H. Smoot, Republic Flow Meters Company, Chicago, Ill. 1951 ASME Semi-Annual Meeting paper No. **51—SA-41** (mimeographed).

THIS paper outlines an electronic servo system used for co-ordination and information transmission in central-




PNEUMATIC POSITION REGULATOR, ELECTRIC POSITIONING ACTUATOR

station combustion controls. It is noted that equipment of this type eliminates the distance lag of pneumatic systems and enables a completely electrical panel installation.

The subject matter of this paper is of interest in the design of control and instrument panels since it permits certain latitudes of equipment arrangement and performance not otherwise easily obtainable. The electrical and electronic devices described do not represent an entirely new system but merely the replacement of portions of existing systems with new components to accomplish its purposes. Reduction of panel area, increase of speed, stability and sensitivity, greater operator convenience, and easier maintenance have been attributed to this system.

The basic principle of operation of this equipment is far from new and is familiar in other fields as a self-balancing a-c Wheatstone bridge. In simplest terms, the mechanism can be conceived as a motion-transmitting system where a mechanical motion determines the resistance ratio of the two left-hand arms of a bridge while the rebalancing mechanism, operating the resistance ratio of the right-hand side of the bridge, also produces the desired mechanical output.

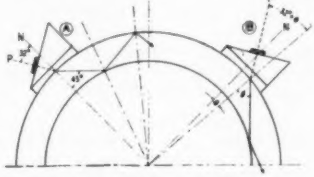
# *Power—Instruments*

**Field Inspection of Boiler Tubes With Ultrasonic Reflectoscope,** by J. A. Tash, Duquesne Light Company, Pittsburgh, Pa. 1951 ASME Semi-Annual Meeting paper No. **51—SA-48** (mimeographed; to be published in Trans. ASME).

REPEATED failures of defective superheater tubes seriously threatened the continued safe operation of two new boilers. To forestall further forced outages it was imperative that the defective tubes be found and removed. Of the several nondestructive inspection methods considered, the ultrasonic shear-wave method and the reflectoscope looked most promising and eventually were successfully used in the field inspection of the tubes. By this means 90 tube sections representing over 1500 ft of defective tubing were detected and replaced.

The basic principles of ultrasonic inspection by both the longitudinal and the shear-wave methods are the same. The material being examined must be homogeneous and be able to transmit a mechanical vibration such as a sound wave, meaning that it has a high modulus of elasticity.

The ultrasonic reflectoscope consists of three essential units, a pulse generator, an oscilloscope, and a searching unit. The last consists of an X-cut quartz crystal which acts as the transducer between electric oscillations and mechanical (ultrasonic) vibrations. The pulse generator produces bursts of electric oscillations which are fed by coaxial cable to the quartz crystal and there converted into ultrasonic vibrations. In the longitudinal wave method these are directed through one surface of the material as narrow beams that are reflected by the opposite face of the material or by a crack, inclusion, or any other discontinuity along the path. The reflected mechanical vibration is picked up and converted by the quartz into electric oscillations which appear on the oscilloscope screen as a "pip" whose displacement from the origin varies with the time for the complete circuit. In the shear-wave technique as used with tubes, the ultrasonic beam is projected at an angle into the tube wall, where it rebounds between inner and outer surfaces until reflected at a discontinuity in the metal, or comes back to the point of origin to be picked up by the searching unit.



A, MANNER OF SHEAR-WAVE PROPAGATION IN TUBE WALL AT 45 DEG TO OUTER SURFACE WHEN WAVE IS CENTERED PROPERLY; B, AT MUCH LARGER ANGLE AT REDUCED SENSITIVITY WHEN INCIDENT SONIC WAVE MAKES ANGLE GREATER THAN 32 DEG WITH TUBE SURFACE

The ultrasonic reflectoscope was found to be a practical tool for the field inspection of small-diameter tubing. Through its use in the furnace and gas passes of two boilers, the 2-in-OD chrome-moly superheater tubes having defects of manufacturing origin were successfully identified. The replacement of these tubes alleviated a serious operating condition.

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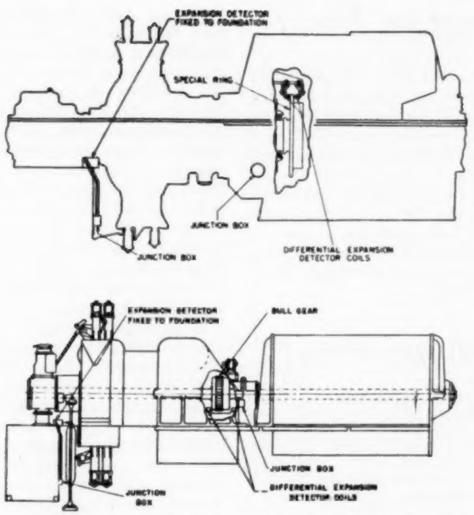
**Supervisory Instruments for Power Generating Equipment—Application and Interpretation of Records,** by E. Y. Stewart and J. H. Reynolds, Jr., General Electric Company, Schenectady, N. Y. 1951 ASME Semi-Annual Meeting paper No. **51—SA-49** (mimeographed; to be published in Trans. ASME).

EQUIPMENT is available to record turbine conditions in terms of shell and




OUTLINE OF TWO TYPICAL TURBINE-GENERATOR SETS SHOWING PHYSICAL LOCATION OF SHELL AND DIFFERENTIAL EXPANSION DETECTORS

(*Top*, detector used with special ring; *bottom*, detector used with ball gear. )

differential expansion, speed and camshaft position, bearing vibration, and shaft eccentricity.

The shell and differential expansion-recording equipment records in alternate sequence the amount of forward expansion of the turbine shell or outer casing, and the differential expansion between the shell and turbine rotor. The measurement of differential expansion not only provides an index to the operating clearances between rotating and stationary elements but provides extremely valuable information for setting up proper starting and operating procedures on the higher-temperature machines.

The speed and camshaft position-recording equipment records the speed when starting up and shutting down the turbine and also gives a measure of the load that the machine is carrying in terms of per cent rotation of the camshaft. This instrument is valuable in analyzing events which take place when the line breaker of the generator opens due to system disturbances.

Bearing vibration recording equipment records the amount of vibration on each of the main bearings of the turbine generator in sequence. This equipment detects immediately disturbances which cause high vibration and also detects gradual long-time changes in vibration due to misalignment.

Shaft eccentricity-recording equipment detects and records, once per revolution, shaft bow. However, it is extremely helpful in detecting a loose thrust sleeve, or runner, which would not otherwise be detected by any other means until actual failure occurred.

A complete set of turbine supervisory instruments are valuable since only a study of all records made by the recorders will give an over-all picture of the operating characteristics of the turbine generator at any particular time. Since the records for any particular machine are peculiar to that unit, normal operating records and records of unusual conditions in the machine should be used by the operators as a guide in operating, detecting unusual conditions, and in the training of operating personnel.

The interest that has been evidenced in the quick starting of turbine generators makes the use of turbine supervisory instruments essential in order to keep track of the rapidly changing conditions.

# *Smoke Abatement*

**Air Pollution and Smoke Abatement,** by O. R. Barefoot, Mem. ASME, Canadian Pacific Railway Company, Toronto, Ontario, Canada. 1951 ASME Semi-Annual Meeting paper No. **51—SA-54** (mimeographed).

SMOKE as we see it consists of small particles of carbonaceous materials resulting from incomplete combustion of fuels, discharged to the atmosphere, remaining in visible suspension for varying periods at varying levels, depending upon the smoke density per unit of volume of the products of combustion, on the prevailing atmospheric conditions, and the topography of the area.

It is acknowledged that some of the criticism directed toward locomotive operation, with respect to smoke emission, is justified; but on the other hand, a considerable amount of this criticism may be considered as optical illusion. For instance, each locomotive has a stack 22 in. in diam, the top of which is located some 14 ft above rail level. Whenever smoke is discharged at this low level, it is immediately obvious to everyone within seeing radius and, of course, registers a grievance in the mind of the observer. An industrial-plant chimney 10 ft in diam and 200 ft high may discharge 20 times the amount of smoke per minute, but due to its height above eye level, is ignored by the same observer. The locomotive may be burning coal at the rate of one ton per hour; the industrial plant 20 tons; but the effect on the observer and his opinion of the former is usually more severe than the latter.

Up to the present time the Ringelmann chart has been accepted as a comparison basis for the determination of smoke densities. The chart has proved effective and simple, and fulfills the requirements until some more practical method is devised.

The Board of Transport Commissioners for Canada include in General Orders and Circulars, Orders dealing with smoke limitations for various cities. The limitations as outlined in the Order are similar to those now in effect in cities of the United States. The General Order issued for any particular city may vary as between Toronto and Montreal, taking into consideration the physical characteristics of the portion of the railroad operating within the prescribed area.

As a matter of information, the first General Order in Canada was issued in 1908, and the limitations of the Order issued at that time covering the cities, towns, or villages in Ontario are as restrictive as any smoke ordinance issued that time in cities of the United States.

The outlined method of smoke limitations is different from that of cities in the United States, in which the prescribed limitations are set up by the City Smoke Ordinance or Smoke By-Law pertaining to that particular city; but in Canada, any Ordinance or Smoke By-Law enacted by a municipality does not cover the operation of steam locomotives. The Railways can be summoned and prosecuted by municipal authorities if found guilty of violation of the Board of Transport Commissioners for Canada General Order

# Doubled-Screened Locomotive Fuels

**Symposium on Performance Experience With Double-Screened Locomotive Fuel,** by Earl C. Payne, Mem. ASME, Pittsburgh Consolidation Coal Company; H. G. Pike, Pittsburgh and Lake Erie Railroad Company; J. S. Swan, Louisville and Nashville Railroad; W. O. Cottingham, Western Maryland Railway Company; and R. M. Pilcher, Norfolk and Western Railroad Company. 1951 ASME Semi-Annual Meeting paper No. **51—SA-51** (mimeographed).

MORE than 15 years ago one of the railroads finally accepted egg coal for certain passenger runs in which time schedules demanded performance and reliability which were not obtainable with run-of-mine. Many attempts were made to broaden this application for other service on the same railroad and to convince other railroads that cheaper run-of-mine was not the best fuel available for a locomotive. An attempt was made to organize a joint co-operative research program, sponsored by the coal industry and railroads, to establish the relative values of double-screened coal and run-of-mine. Lassitude and direct opposition within the coal industry were convincing proof that the advantages of the application of double-screened coal would have to be sold to each railroad individually. Some coal-producing districts had already demonstrated that elimination of the fine coal from run-of-mine produced an acceptable locomotive fuel from coals which otherwise could not be used in run-of-mine grades for locomotives in road service. Even this experience was an insufficient demonstration that acceptable run-of-mine coals would be substantially improved for locomotive use by eliminating the fines and establishing top and bottom screening limits.

This promotion of double-screened coal for locomotive use has been a slow and disheartening job. Beginning with only one railroad, it has taken more than 10 years to arrive at the present situation in which at least 22 of the eastern railroads prefer double-screened coal for all of their engine fuel requirements. In the author's (E. C. Payne) opinion, there is absolutely no doubt that double-screened coal will save at least 20 per cent of the run-of-mine fuel bill and more, if proper credit is given to the intangibles which can be evaluated only after two to three years' use.

Experienced railroad-operating men joined in a panel presentation in which it is shown that double-screened coal sizes are much more satisfactory for use on road locomotives than the run-of-mine coal, long used for engine fuel by the railroads.

These representative railroads reveal tangible savings which are both positive and substantial and also describe many other intangible benefits which they cannot directly evaluate, since they have changed over to the use of double-screened coal. The benefits of prepared coal for locomotive use are no longer just theory or a matter of a few isolated road observations or test plant demonstrations. Net savings have been irrefutably confirmed by substantial reductions in the annual fuel bill.

# Marine Power

**Geared-Turbine Repowering for Great Lakes Vessels,** by F. H. Van Nest, General Electric Company, West Lynn, Mass., and B. E. Ericson, Pittsburgh Steamship Company, Cleveland, Ohio. 1951 ASME Semi-Annual Meeting paper No. **51—SA-44** (mimeographed).

EARLY in the 1951 season of navigation on the Great Lakes, work was completed on the repowering of two sister ships of the Pittsburgh Steamship Company of Cleveland, Ohio. This program added some 110,000 long tons to the annual ore-carrying capacity of this U. S. Steel Company subsidiary which operates over 60 large bulk freighters on these "sweetwater" inland seas.

The twin vessels, *Eugene W. Pargny* and *Homer D. Williams*, standard 600-ft lake ore vessels, originally propelled by reciprocating triple-expansion steam engines fed with steam from hand-fired coal-burning Scotch-type boilers, were converted at the Lorain, Ohio, yard of the American Shipbuilding Company. The project provides an interesting study of comparisons, design, and economy, inasmuch as two entirely different types of propulsive machinery—one a geared Diesel and the other a geared turbine—replace the old power plants.

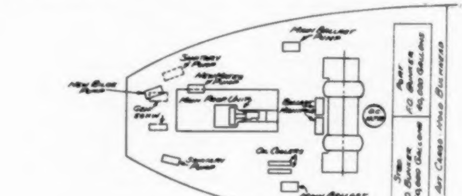
The new machinery was designed to increase the speed of the old ships nearly 2 mph so that faster trip schedules will give greater seasonal capacity and consequent gains in economy.

In this paper some of the design features and economic considerations of the geared-turbine installation are presented.

The *Williams* has been repowered with a geared turbine of a type which is an innovation on the Great Lakes, a design particularly adaptable to this kind of conversion. This propulsion unit is made up of a single-cylinder turbine and a double-reduction locked-train single-helical-gear set, rated at 3000 shp with a turbine speed of about 8000 rpm and a propeller speed of 110 rpm, and is designed for 10 per cent overload. An astern turbine is provided on the low-pressure end of the rotor.

The turbine will operate at 440-psig pressure and 740 F, exhausting to a vacuum of 28.5 to 29 in. Hg, and will require about 21,000 lb of steam per hr for normal running power at sea.

Steam for the *Williams* will be generated by two oil-fired two-drum bent-



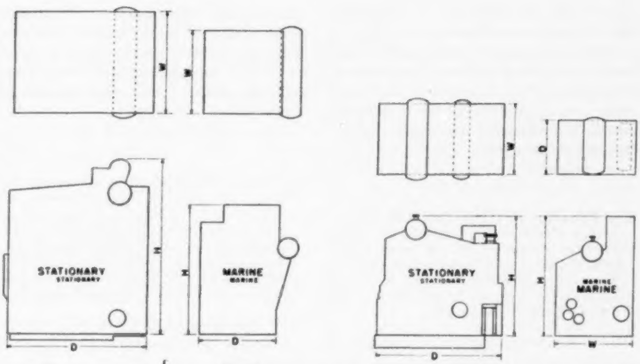
MACHINERY ARRANGEMENT AFTER REPOWERING, SHOWING GEARED-TURBINE AND WATER-TUBE BOILERS

tube boilers, designed with rear, side, and roof waterwalls and fitted with superheaters, economizers, forced-draft fans, and completely automatic, all-electric combustion control.

Each boiler will be able to generate 15,000 lb of steam per hr at 450-psig pressure and 750 F at the superheater outlets, with a feed temperature of 240 F, at normal 3000-shp turbine load, with 125 per cent overload capacity.

Two recent developments in gear-cutting technique have made possible the very compact and lightweight gear design. The first is the development of hobbing equipment which can cut pinions from much harder material than has been possible in the past. The second was the development of gear-tooth shaving equipment which is used as a final operation to improve surface finish and refine the tooth profile and helix angle.

With the hardened pinions more precisely cut than ever before, the tooth loading can be considerably increased without decreasing the degree of conservatism built into the gear.




| Oil Refinery | [illegible] SHP Tanker | Application | Manufacturing Plant | 7000 SHP Ore Carrier |
|---|---|---|---|---|
| 60000 | 63000 | Normal Evaporation ... lb/hr | 36000 | 32000 |
| 75000 | 78000 | Maximum Evaporation ... lb/hr | 45000 | 40000 |
| 425 | 650 | Operating Pressure ... psig | 165 | 450 |
| 685 | 1020 | Total Steam Temperature ... F | Sat | 750 |
| 81.4 | 88.0 | Efficiency ... pct | 85.0 | 86.0 |
| 1735 | 740 | Box Volume ... cu ft | 790 | 384 |
| 100 | 42.6 | Box Volume ... pct | 100 | 48.6 |

SIZE COMPARISON, STATIONARY VERSUS MARINE BOILERS

**Reboilering the *Homer D. Williams*,** by George J. Kirschner, Foster-Wheeler Corporation, New York, N. Y. 1951 ASME Semi-Annual Meeting paper No. **51—SA-52** (mimeographed).

THE *SS Homer D. Williams* was delivered to the American Shipbuilding Company yard at Lorain, Ohio, in December, 1950, and the work of removing the superstructure over the engine and five rooms was immediately begun. The Scotch boilers were lifted from the ship as units and were later cut into scrap on the dock. Simultaneously, erection of the new boilers was begun in the boiler shop of the shipyard.

Two Foster Wheeler D-type boilers were chosen. This type of boiler was selected in preference to the cross drum because of its greater flexibility, low furnace maintenance, and the fact that battery set, stack, and breeching costs can be greatly reduced. Also, the characteristic shape of the D-type boiler makes it exceedingly adaptable for general use aboard ship where space is limited.

Each boiler is of the single-pass design and is equipped with convection-type superheaters, waterwalls, and economizers. Two steam atomizing fuel-oil burners are located in the front of each boiler.

It has been found that where crane power and lifting gear are available, a considerable saving can be realized by assembling the boilers in the shop rather than on the ship. Tools and power are more accessible and the general working conditions are more favorable when the boilers are assembled in the shop of the shipyard.

In lifting the boilers aboard the ship, the foundation served as a cradle to which the lifting gear was attached. By lifting the unit in this manner no strain was imposed upon the boiler proper.

The boilers, in accordance with modern practice, are located in a flat about 10 ft above the tank tops. The boiler fronts face the engine room and there is no bulkhead separating the engine room from the fire room. The watch engineer when standing on the operating platform will be able to see and if necessary supervise the operation of the boiler at all times.

The boilers are supported on six pedestals. These pedestals are clean cut and simple in appearance and should give excellent support to the boilers.

**Some Developments in Marine-Boiler Design,** by S. F. Mumford, Mem. ASME, Combustion Engineering-Superheater, Inc., New York, N. Y. 1951 ASME Semi-Annual Meeting paper No. **51—SA-53** (mimeographed).

THE space for installation of boilers aboard ship is limited. Boilers must therefore be compact yet designed for high efficiency, good accessibility, and low maintenance. Recent developments have been influenced either directly or indirectly by these requirements.

The extensive use of water-cooled furnace walls permits efficient combustion in a relatively small furnace volume. Improved designs of extended-surface economizers and superheaters provide good accessibility for inspection, cleaning, and maintenance and considerably simplified casing construction.

Because of the small physical size of marine boilers, shop assembly of components is feasible, reducing shipyard erection time and expense.

The controlled circulation boiler has many inherent advantages making it ideally suited for high-pressure and high-capacity marine applications.

# *Applied Mechanics*

**Vibrations of a Clamped Circular Plate Carrying Concentrated Mass,** by R. E. Roberson, Jun. ASME, Naval Research Laboratory, Washington, D. C. 1951 ASME Applied Mechanics Division West Coast Conference paper No. **51—APM-5** (in type; to be published in the *Journal of Applied Mechanics*).

THE vibrations of a circular plate clamped at its edge and carrying a concentrated mass at its center are considered. The plate is excited by a motion of the framing, assumed rigid, to which it is clamped. The first four natural frequencies are displayed graphically as functions of mass ratio, and are calculated more precisely for $\mu = 0$, $\mu = 0.05$, and $\mu = 0.10$. The motions of two subsystems with one degree of freedom are compared, one subsystem being driven by the framing and the other by the concentrated mass on the plate. The plate-mounted subsystem has a response in ex-

cess of the response of the framing-mounted subsystem if the framing is suddenly put into motion with constant velocity. Except in the neighborhood of their peaks, whose locations depend upon mass ratio, the subsystem resonance curves are depressed in height by increasing the mass ratio.

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**The Behavior of Graphite Under Alternating Stress,** by Leon Green, Jr., North American Aviation, Inc., Downey, Calif. 1951 ASME Applied Mechanics Division West Coast Conference paper No. **51—APM-3** (in type; to be published in the *Journal of Applied Mechanics*).

THE fatigue properties of grade AUF extruded polycrystalline graphite were investigated at ambient and elevated temperatures. Specimens cut parallel to the axis of extrusion were stressed in reversed bending at room temperature and at 3550 F. The endurance limit of this graphite was found to increase from 2500 psi at room temperature to about 4400 psi at 3550 F. The increase in endurance limit is correlative with the increase in short-time tensile strength with temperature observed in earlier studies of graphite.

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**A General Method of Calculating the $M_{t_{max}}$ Diagram in Plastic Bending of Beams,** by Aris Phillips, Mechanical Engineering Department, Stanford University, Stanford, Calif. 1951 ASME Applied Mechanics Division West Coast Conference paper No. **51—APM-6** (in type; to be published in the *Journal of Applied Mechanics*).

IN this paper a new method is given for finding the $M_{t_{max}}$ curve in the case of symmetrical pure bending of bars in plasticity. This method is both accurate and comparatively easy to use. At the end of the paper it is shown how it is possible to express any $\sigma$-$\epsilon$ curve as the sum of a number of elastic-plastic stress-strain lines.

# *Oil and Gas Power*

**Water-Cooling Equipment for Diesel and Gas Engines,** by H. E. Degler, Mem. ASME, The Marley Company, Kansas City, Kan. 1951 ASME Oil and Gas Power Division Conference paper No. **51—OGP-6** (mimeographed; to be published in Trans. ASME).

THE choice of a cooling system for large engines will depend upon (1) cost and availability of water, (2) quality of water, (3) geographical location, (4) space available, and (5) desire to utilize waste heat. If a plentiful supply of good-quality water (soft) is available at a low cost, a simple open cooling system may be satisfactory with the cooling water going to waste; for small engines (less than 200 hp) a core-type water-air radiator is frequently used.

The re-use of cooling water has become a necessity in many areas because of cost, water hardness, availability, or legal restrictions. The most common methods for cooling and re-use of the circulating water are: water-cooling towers, evaporative coolers, and air-cooled heat exchangers.

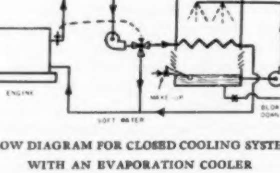
The type of water-cooling equipment used affects to a considerable extent the operating temperatures of an engine. Some types of equipment such as spray ponds and natural-draft cooling towers, that depend upon prevailing winds for cooling the water, must be designed and built for low-wind-velocity conditions. Such equipment cannot continuously maintain a close approach to the wet-bulb air temperature, hence mechanical-draft cooling equipment must be employed to produce the necessary air movement and obtain the desired engine-operating temperatures.

Natural-draft towers should be used only (1) when the engines served can operate satisfactorily at the higher water temperatures resulting from low or zero-wind velocities during hot weather; (2) where drift from the tower is not objectionable; and (3) when the tower can be placed so that the wind will not be cut off by buildings, trees, and the like.

On the other hand, performance of induced-draft water-cooling towers is independent of wind velocity, hence it is possible to design them for more exacting performance.

Another closed system for jacket water cooling includes "low-fin" tube coils in an evaporative cooler. Cooling is accomplished by the evaporative effect of the raw water on the finned coil surfaces.

With an air-cooled heat exchanger there is negligible make-up water required, hence scale and deposit problems are unlikely.




FLOW DIAGRAM FOR CLOSED COOLING SYSTEM WITH AN EVAPORATION COOLER

The dry surface cooler and the water-cooling tower each has its own preferred applications, but in many cases for cooling jacket water either type may be used.

In general, the dry-surface air-cooled heat exchanger may be used in preference to the water-cooling tower for applications where water is scarce and expensive, badly polluted, or where the "portable" characteristics of the dry cooler are desirable.

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**Design of the Exhaust Snubber for Gas Engines,** by R. L. Leadbetter, Burgess-Manning Company, Dallas, Texas. 1951 ASME Oil and Gas Power Division Conference paper No. **51—OGP-1** (mimeographed).

THE exhaust snubber must withstand the explosion forces involved in gas-engine service, and there is a limit to permissible weight of the unit. Since the gas is dry and no corrosion allowance is required, there is no justification for building the exhaust snubbers like pressure vessels.

The design problem of the exhaust snubber for the gas engine, therefore, is such that the device must not fail mechanically as the result of exhaust explosion, and the weight should not be excessive. This means putting the strength where it is required. If explosion-relief devices are used they should most certainly be located at points of maximum pressure rise. The value of explosion-relief devices is a controversial subject for the simple reason that the whole cycle of the explosion is probably over before gas in any appreciable quantity has escaped through the relief opening. Only the slow-burning mixtures that would not result in violent explosions will vent through the relief opening.

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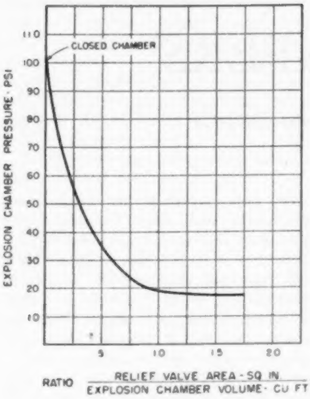
**Damage Prevention From Diesel-Engine Crankcase Explosions,** by A. C. Cavileer, U. S. Naval Engineering Experiment Station, Annapolis, Md. 1951 ASME Oil and Gas Power Division Conference paper No. **51—OGP-3** (mimeographed; to be published in Trans. ASME).

THE Internal Combustion Engine Laboratory of the U. S. Naval Engineering Experiment Station has been investigating this problem from the ship's operation standpoint, and it is the purpose of this paper to present some of the results of these investigations. As the world's largest user of Diesel engines, the U. S. Navy has a vital interest in correcting anything which impairs the efficiency of its ships or crews.

From the test work which has been completed the Navy has drawn the fol-




EFFECT OF RELIEF-VALVE AREA ON EXPLOSION-CHAMBER PRESSURE

lowing conclusions: (1) The test setup and method which have been used are satisfactory for testing the adequacy of crankcase doors to withstand crankcase explosions; (2) the relief area for crankcases should be approximately 1.5 sq in. for each cu ft of volume of the crankcase; (3) lightweight multiple-relief valves are desirable along the length of the engine crankcase; (4) relief valves should be capable of relieving pressures in excess of 20 psi; (5) good gasket cementing techniques, with some type of flame protection should be used to prevent loss or burning of gaskets as a result of an explosion; and (6) all parts of a crankcase should be capable of withstanding an explosive force of 20 psi.

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**Diesel-Engine Crankcase Explosion Investigation,** by G. W. Ferguson, The Texas Company, New York, N. Y. 1951 ASME Oil and Gas Power Division Conference paper No. **51—OGP-2** (mimeographed; to be published in Trans. ASME).

THIS paper presents information gained from a study of the lubricating-oil aspects of crankcase explosions. Experimental tests indicate the crankcase atmosphere of a Diesel engine is a potentially inflammable mixture of oil mist and air in which ignition may be initiated by an overheated part. The minimum ignition temperature of an oil mist/air mixture is reduced by decreased air flow, increased mixture temperature, and increased igniter size.

No significant differences were found in the minimum ignition temperature of a wide variety of lubricating oils, even when diluted with up to 20 per cent Diesel fuel. As long as inflammable lubricants are employed, it appears that little can be done from a lubricating-oil or fuel standpoint to prevent crankcase explosions. It is indicated that the problem may best be attacked by further critical studies of operation and maintenance practices and continued refinements in engine design.

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**The Modern Gas Engine,** by R. L. Boyer, Mem. ASME, and W. R. Crooks, The Cooper-Bessemer Corporation, Mt. Vernon, Ohio. 1951 ASME Oil and Gas Power Division Conference paper No. **51—OGP-4** (mimeographed).

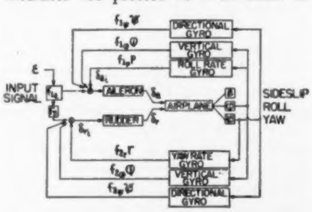
THE modern gas engine, which this paper discusses, had its latest major development during 1945 when it was discovered how to burn gas on the Otto cycle engines having high compression. Detail steps of the commercial application, and the economics of power production are discussed.

This paper covers the larger sizes of heavy-duty engines using gas for fuel. Most of the engines described are spark-ignited; however, the gas-Diesel or dual-fuel engines with pilot oil ignition are also covered. Natural gas is the basic fuel considered; however, propane and butane gases are briefly discussed. This paper does not cover engines using carbureted liquid fuels, automotive type of engines, or applications.

# *Instruments*

**Automatic Flight Control—Analysis and Synthesis of Lateral-Control Problem,** by R. N. Bretoi, Minneapolis-Honeywell Regulator Company, Minneapolis, Minn. 1951 Joint ASME Industrial Instruments and Regulators Division—Instrument Society of America Conference paper No. **51—IIRD-1** (in type; to be published in Trans. ASME.)

A METHOD is presented which is useful in the analysis and synthesis of the aircraft lateral-control problem. Consideration is given to establishing autopilot requirements necessary to accomplish fast, stable, and co-ordinated (zero sideslip) response. Charts are derived whereby responses of the controlled variables are plotted as a function of dimensionless time for systems represented by a second-order (e.g., simplified roll or simplified one-degree-of-freedom-yaw response), or by a third-order (e.g., simplified co-ordinated directional control) linear-differential equation. Included is the derivation of a method for establishing autopilot requirements necessary for dynamic and steady-state co-ordination. The use of the analog computer in aiding the analysis and the effects of control lags are discussed briefly. Comparisons are made between aircraft responses calculated by means of the simplified equations, aircraft responses obtained from simulated flight recordings on the analog computer, and aircraft responses recorded during flight tests.




BLOCK DIAGRAM OF BASIC AUTOPILOT

## ASME Transactions for September, 1951

The September, 1951, issue of the Transactions of the ASME, which is the *Journal of Applied Mechanics* (available at $1 per copy to ASME members; $1.50 to nonmembers) contains the following:

TECHNICAL PAPERS

Stresses in Pipe Bundles, by H. Poritsky and G. Horvay. (50—A-80)

A Note on Elastic Surface Deformation, by Murray Kornhauser. (50—A-30)

Velocity Distributions and Design Data for Ideal Incompressible Flow Through Cascades of Airfoils, by Robert Resnick and L. J. Green. (50—A-31)

Approximate Solutions of Compressible Flows Past Bodies of Revolution by Variational Method, by Chi-Teh Wang and Socrates de los Santos. (50—A-33)

On the Extrusion of a Very Viscous Liquid, by Herschel Weil. (50—A-8)

On Elastic Continua With Hereditary Characteristics, by Enrico Volterra. (50—A-32)

Transverse Vibrations of a Free Circular Plate Carrying Concentrated Mass, by R. E. Roberson. (50—A-24)

Analysis of Straight and Curved Beam-Columns, by C. M. Tyler, Jr., and J. G. Christiano. (50—A-11)

Sinusoidal Torsional Buckling of Bars of Angle Section Under Bending Loads, as a Problem in Plate Theory, by H. J. Plass, Jr., (50—A-15)

A Statistical Distribution Function of Wide Applicability, by Waloddi Weibull. (51—A-6)

DESIGN DATA AND METHODS

Applying Bearing Theory to the Analysis and Design of Journal Bearings, by John Boyd and A. A. Raimondi. Parts I and II.

DISCUSSION

On Previously Published Papers by N. J. Hoff; and J. T. Bergen and G. W. Scott, Jr.

BOOK REVIEWS

ABSTRACTS

Papers presented at the First U. S. National Congress of Applied Mechanics.

# COMMENTS ON PAPERS

*Including Letters From Readers on Miscellaneous Subjects*

## Engineering for Small Plants

COMMENT BY GREGORY M. DEXTER[1]

The field for engineering services is much broader than suggested in this paper.[2]

If the manager has not had engineering training, the field for the engineer in a small plant includes analysis of advertising and sales expenses, determination of the best advertising mediums and sales territories, decisions as to the proper amounts to spend on advertising and sales on a better basis than a percentage of sales dollars, improved methods for selecting salesmen, and related problems.

The small plant also frequently needs a simple but worth-while cost-accounting system, and here the engineer can be of great value.

The foregoing applications of engineering service may mean more in profits to the small company than the more basic engineering techniques outlined in the paper. An engineer's training in wanting to know "why?" should be invaluable in examining advertising, sales, and accounting policies. He may not have sufficient judgment to tell management exactly what to do without the assistance of experts in advertising, sales, and accounting, but he certainly should be able to convince the management of the necessity to examine more critically its policies in such fields.

COMMENT BY JAMES A. QUAID[3]

The author has mentioned that small plants have available, through their material and equipment suppliers, engineering assistance which is most helpful in the solution of numerous problems inherent with the successful development of a small plant. He has written from experience in production and semiproduction. However, in the field of custom and job fabrication, which is keenly competitive, it becomes more necessary to rely on such outside help on engineering problems.

A small plant receiving the bulk of its business locally and from a few surrounding states, is expected to solve the problems of its customers, which are numerous, complex, and challenging. It is not economically possible to employ a complete engineering staff capable of solving all engineering problems. A small engineering staff, properly guided by engineering-minded management, can quickly resolve the data required and arrive at solutions through the help of the engineering and research departments of their vendors. Manufacturers of machinery, equipment, and materials of construction offer the assistance of their staffs, merely for the asking.

In one particular case, a metal fabricator was given the order to build ten high-tensile aluminum vessels of a design which had never before been employed. The fabricator agreed with the proposed plans of the designers and, in the course of the construction of the first units, it was evident that costs were excessive owing to stresses set up in welding which no amount of jigging or change of technique could correct. A manufacturer of welding equipment was called in, studied the difficulty, and in 2 weeks made up a special welding machine which eliminated 80 per cent of the distortion and reduced welding time to 25 per cent of that required for the former method. The process used was an automatic one which had just been perfected and used initially on experimental naval craft.

In this same plant, with postwar expansion to care for increased business, expenditures for several items of shop supplies mounted seemingly out of proportion to requirements. One of these items was abrasives in various forms for the finishing of welds and fabrication of stainless steel and alloys. An engineering study was made by one supplier of abrasives which extended over a 3-week observation and checking period. At the conclusion, a planned sequence of use of abrasives was established whereby some wheels and belts were utilized for three and four operations which formerly were used exclusively for one or two operations and then discarded. By means of this study, workmen became conscious of their waste, increased their efficiency, and improved the quality of their work, which resulted in a conservative estimate of savings on finishing of approximately 20 per cent. In a large plant engaged in production work, a similar survey probably would be conducted by plant engineering personnel, and the cost would be absorbed by overhead. A small plant, engaged in either production or specialty work, can secure the same benefits at practically no cost.

The author states in his opening remarks, "The use of engineering assistance in small plants is recognized as essential by those which survive as the fittest." He states further, "The small plant grows only if integrity and knowledge are applied intelligently." We know that on a percentage basis the proportion of business failures in small plants is approximately nine times that in large plants. Almost invariably the principal reason for small plants failing is the absence of application of sound engineering plans to reduce manufacturing costs.

An expanding economy will force all plants to employ engineering solutions to meet production requirements, but a plant in which management is continually engineering-conscious will be able to meet production requirements, sell at a lower price, and show a greater profit.

COMMENT BY D. K. SWARTWOUT[4]

The author clearly presents the manifold ways in which a small enterprise can profit through a proper engineering approach to its problems.

Under the heading "Eliminate Obsolete Machine Tools," the author states that the machine tool which is most nearly automatic . . . . is the most economical to use. He is certainly right. But as more automatic machinery is introduced, a wholly new human problem appears, and this problem is often overlooked by both the engineer and management. In fact, the failure of management to see this problem may have much to do with labor unrest today. Because,

[1] Consulting Engineer, Scarsdale, N. Y. Mem. ASME.

[2] "New Tasks in Engineering for Small Plants," by F. W. Miller, MECHANICAL ENGINEERING, vol. 73, June, 1951, pp. 481–483 and 499.

[3] Partner, Martin-Quaid Company, Philadelphia, Pa. Mem. ASME.

[4] President, The Swartwout Company, Cleveland, Ohio.

once machinery becomes so automatic that the operator no longer can demonstrate his skill in the way he could when craftsmanship was required, there is left a void. Management must recognize this and see that this void is filled with a new and deeper interest in the operation of the business.

Even if failure on the part of management to make possible this greater interest does not lead to actual unrest, nevertheless it may prevent the workman making a real contribution to the welfare of the business. Whether our business is large or small, the need today is to develop the maximum opportunity for each and every associate to make his greatest contribution to the success of the enterprise.

To the discussion under Engineering Specifications the writer would like to add one additional thought. We have found it highly desirable to accumulate a list of standard sizes and types of materials which we will use along with standard tools. Then we require the design engineer to make his selection from these standards if he can do so without sacrificing any feature of his design. Before we followed this procedure, we found that, with the whole world to choose from, engineers soon loaded us down with many more items in inventory and a larger investment in tools than was really necessary.

As the author says, ofttimes the facilities of a commercial laboratory, a college laboratory, or a consultant, can be used to advantage. But many businesses, although small, can much more economically do their research work within their own organizations. That is largely true in the case of our company. However, when we have tried to do this, we have found our greatest difficulty is not in the selection of competent personnel, but in keeping them on the research jobs. If the operation is large enough so they can be locked up in a separate building—well and good. But most small companies cannot do that. If one is dealing with operating equipment, as we are, there is an ever-present temptation to borrow these people from the research work when an especially tough problem is to be handled, either at home or out in the field. It takes a great deal of courage, and a constant devotion to the need for research work, to keep such distractions under control.

### COMMENT BY L. PIERRE TEILLON[6]

As stated by the author, engineering assistance is essential to the small plant which strives for success, as well as the large plant which already has attained a stable and successful position in its industry. However, recognition by small-plant managers may be widespread in an idealistic sense, but it is all too small and scattered in a sense realistic enough to lead to action and practical application. There are several difficulties which hinder more widespread action by small concerns in applying engineering; of these, smallness itself, diversity, and evaluation of the program are prominent examples.

The small plant and, therefore, the smallness of its operations and whole plant are difficult barriers to be overcome in obtaining recognition of the value of applied engineering. However successful the small plant may be, the personnel involved still generally think "engineering is all right for the big fellow, where he's handling tens of thousands and millions and can afford a big overhead, but we're just peanuts and we couldn't afford it anyhow." Like all half-truths, the danger in this is its true content, which is enough to influence and convince otherwise very successful men. It is more difficult for engineering to make a showing in a small operation, and the results never can be as large in an absolute sense as in a large one, but a well-engineered "peanut" is as profitable relatively as a well-engineered "watermelon." If specialized engineering, which would be limited in its scope by smallness, is needed, it should be purchased intermittently as needed and at a cost commensurate with return, or general engineering assistance should be obtained which can be occupied continuously and show a continuous return by directing its efforts into all the various factors involved in the small business.

Another factor of the small plant closely allied to smallness itself is diversity. Not only is the plant and operation small (even at the optimum possibility of one product, this quantity cannot be too large by virtue of the plant size) but, also if added to this, there is diversity in the products of the small plant or complexity or great number of operations involved, the factor of smallness shrinks still further into seeming insignificance. Here, engineering is faced with a problem of flexibility rather than the simpler problem of specialization more often found in large concerns. The small concern of this type definitely would have more difficulty in recognizing the advantages of engineering assistance than in most any other type concern, for engineering itself lags more in this field than in any other. It is all too easy to illustrate the advantages of specially built machines, special methods, and handling, where the operation is large enough to multiply small unit gains into large values to warrant the costs. In diversity and flexibility, it is more difficult to determine the point of diminishing returns of a general-use machine against specialized ones in its loss of efficiency in each of many operations done by it, compared to several specialized ones; all this in comparison to investment, cost of operation, and operations to be called for tomorrow and unknown today.

Both of the foregoing points are factors in the third, i.e., evaluation of an engineering program. Real recognition of the value or essentiality of something is to be "sold on it." The American public and thus the American businessman, small and large, does not buy, he is sold. He is also hardheaded enough to consider carefully before he spends positive dollars for possible results. Therefore, especially in regard to small concerns, it is necessary that engineering properly evaluate its program for the client or employer in terms of dollars, profit, or value received, in such a manner that the points of resistance such as those mentioned, which in themselves are difficult problems for the engineer, are clearly covered and minimum as well as maximum results are indicated.

Proper evaluation of engineering assistance in realistic terms of cost and return, covering both minimum and maximum factors in each case, and clearly indicating the difficulties inherent in the particular application, would be the greatest impetus to a more general and realistic recognition of its value by small concerns.

### AUTHOR'S CLOSURE

The paper which the author was invited to write was well-defined in its scope. This was welcome since practical experience during the past six years has proved the wisdom of completing the tasks described. These tasks, as satisfactorily completed and outlined in the paper, are not intended to be all-inclusive but rather illustrative. The engineering approach to other essential small plant functions, as suggested by Mr. Dexter, can be markedly effective in contributing to the success of the small plant.

The author compliments Mr. Quaid on his valuable contribution to the solution of tasks facing managers of small businesses. Calling on the manufacturers and suppliers of industrial equipment for engineering assistance is a desirable means of obtaining expert advice.

[6] Secretary-Treasurer, and Industrial Engineer, Automatic Temperature Control Company, Inc., Philadelphia, Pa.

Mr. Swartwout writes as one having rich experiences and a desire to share these with others. He speaks feelingly of the "personal equation," and this is important in realizing the proper spirit in any plant. These remarks are commended to small-plant managers.

Mr. Teillon has contributed ideas which are essential to the success of small-plant operations. He refers particularly to the cost of improving methods and tooling. However, this cost should not discourage a small-plant manager. Most studies will prove the wisdom of some investment, amortizing it over a short term.

Mr. Teillon refers to the adverse effect of diversity on tooling and methods. To the degree to which it can be effective, it is equally as important. We should all show a high regard for this fact. He has wisely called attention to the limitations where great diversity exists.

F. W. MILLER.[6]

[6] Vice-President (Mfg.), Yarnall-Waring Company, Philadelphia, Pa. Mem. ASME.

# REVIEWS OF BOOKS

*And Notes on Books Received in the Engineering Societies Library*

## Mineral Industries Education

MINERAL INDUSTRIES EDUCATION. By Edward Steidle. The Pennsylvania State College, State College, Pa., 1950. Cloth, $5^{1}/_{4} \times 9$ in., mineral map of Pennsylvania on end papers, 23 figs., xv and 252 pp., $3. The book can be secured from PSC, Mineral Industries Extension Services.

REVIEWED BY CLYDE E. WILLIAMS[1]

READERS have learned to expect something concrete and instructive from the pen of Dean Edward Steidle. His new book is no disappointment to his old readers. The thesis of the book is set forth in the preface in these words, "We insist that man must be weaned from his egocentric thinking to consideration of what is best for the most, that he must desist from useless exploitation and destruction of man and nature for personal benefit and initiate a program of conservation if he is to survive."

This book is in effect a combination and reprint of three former circulars from Pennsylvania State College: Circular 31, "Roots of Human Progress"; Circular 33, "A Philosophy of Conservation"; and Circular 35, "Wanted: Mineral Industries Colleges." These three circulars form the titles of the three parts of the new book.

Dean Steidle has presented a philosophical treatise dealing with man, his ethics and shortcomings; the degradation of our mineral resources and their necessity to our American standard of living. With depleting and lower-grade mineral deposits the ingenuity of man and research are called on to offset nature's rich deposits which have been and are being exploited. Properly trained men are necessary to meet the challenge and these men must not be narrow technologists in a special field but well-trained personnel with humanitarian and economic background.

His philosophy can probably be summarized in the following basic considerations: (1) The world and the public as a whole must be made more mineral-conscious. (2) Educate the trained man. (3) Expand the knowledge of the fundamental properties of minerals. (4) Maintain the knowledge that common hazards must be met with a common front. (5) Achieve greater understanding through congresses, technical conferences, exchange professors, exchange students, technological aids; and aid in the training of skilled technicians.

The School of Mineral Industries of Pennsylvania State College has been established to train men for those ends. Dean Steidle gives the history and background of the School.

The book is recommended as a "must" for educators in the field of mineral technology It also should be read by men in research and those to whom our heritage of minerals is invested. It is well written and recommended for general reading. It is profusely illustrated with woodcuts and diagrams. The front and back covers comprise a colored map showing the known sources of primary wealth, both mineral and nonmineral, of the Commonwealth of Pennsylvania.

[1] Director, Battelle Memorial Institute, Columbus, Ohio. Mem. ASME.

### *Library Services*

ENGINEERING Societies Library books may be borrowed by mail by ASME Members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any items in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

## Prefabricated-House Industry

THE PREFABRICATION OF HOUSES: A Study by the Albert Farwell Bemis Foundation of the Prefabrication Industry in the United States. By Burnham Kelly. Published jointly by The Technology Press, Massachusetts Institute of Technology, Cambridge, Mass., and John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, Ltd., London, England, 1951. Cloth, $6 \times 9^{1}/_{4}$ in., 143 illus., bibliography, appendixes, index, xxii and 466 pp., $7.50.

REVIEWED BY EDWARD H. HEMPEL[2]

THIS book should be of special interest to publishers and writers, as well as to readers interested in this field, because it represents more than the usual kinds of newnesses claimed for almost any book.

Publishers should watch the sale of this book because within its covers it presents the economic, management, and technical aspects of a complex and new industry, a feat which has been rarely attempted so far in one volume. If this sort of presentation should go over well, there should be room for many more books of this kind covering other industries.

Writers of books on industrial subjects of the monographic type also will do well to take notice of this book, espe-

[2] Co-ordinator, Small Plant Management Program, Management Institute, New York University, N. Y. Mem. ASME.

cially of the style of writing used by the author and the thoroughness in the coverage of the entire subject matter. The style avoids too-technical language, offers some, but not too many figures, and thus presents the entire subject in what may be called a "layman's style," which may or may not become popular with the readers.

The reader of this book undeniably obtains an insight into the beginnings, trials, and tribulations of a new industry, which otherwise he could obtain only through many years of contact or research.

The subject and desires of acquiring a low-cost, prefabricated home are latent in many people. All are well covered and catered to in the book from the economic, social, management, production, sales, and cost angles. Even the purchasing of materials by the producers, and productivity as achieved in making and erecting prefabricated houses are covered interestingly and adequately.

Of all the parts of the book those covering the technical aspects of design, construction, and erection, will interest the technical-minded readers most. These sections reveal an as yet not fully developed, but gradually consolidating fund of knowledge and experience, which undoubtedly will someday yield a truly suitable prefabricated house.

In spite of all the information offered on costs and investments made by producers, the layman may well wonder why the costs of prefabricated homes are still almost the same as those made completely on the site, and above all, it is somewhat discouraging to learn that England seems to be ahead of American prefabricators in providing livable homes at truly low costs and prices. Could we by any chance learn more about this from England?

Although the book goes into almost any details, it does not cover adequately some highly important points—the experience, feeling, and satisfaction obtained by those who so far have bought prefabricated homes. Only on pages 62 and 63 it is said: "A consumer-opinion poll conducted by the Curtis Publishing Company in August, 1944, showed that while 74.5 per cent of those interviewed had heard of prefabricated houses, only 17.2 per cent of these would consider buying one to live in all year round. The reason given most frequently by the potential home owner for not buying a prefabricated house was lack of strength. Obviously, lightness was being confused with weakness, and speedy erection with short life."

It does seem that a poll among those who already live in such houses would have produced more useful answers to this question, which would have helped not only the many who will want a low-cost house of their own, but would have given the perfect send-off to this truly interesting and valuable book.

"The manufactured house, whether partly or almost wholly prefabricated, is no longer experimental. It is a potent and still evolving factor in housing today."

# Inelastic Behavior of Engineering Materials

THE INELASTIC BEHAVIOR OF ENGINEERING MATERIALS AND STRUCTURES. By Alfred M. Freudenthal. John Wiley and Sons, Inc., New York, N. Y.; Chapman and Hall, Ltd., London, England, 1950. Cloth, $5^1/_4 \times 8^1/_2$ in., figs., tables, references, author and subject indexes, xvi and 587 pp., $7.50.

REVIEWED BY A. NADAI[3]

THIS book of 18 chapters is divided in three major parts under the headings: "The Structural Aspects of Mechanical Behavior," pages 27 to 164, "Mechanics of Inelastic Deformation," pages 167 to 414, and "Application of the Mechanics of Inelastic Behavior," pages 417 to 574, with an introductory chapter of 26 pages devoted to "purpose of the study of mechanical properties of materials" from various "levels of approach."

[3] Worcester Reed Warner Medalist, 1947; retired, Pittsburgh, Pa. Fellow ASME.

In the preface the author states that the knowledge of "present-day engineering students seldom progresses beyond the level of elementary theory of elasticity and strength" and "too often in engineering practice an attempt is made to interpret the mechanical behavior of real materials solely in terms of elastic theory rather than to consider the nature of the material and its actual response to forces as the manifestation of its heterogeneous internal structure. . . . The unifying principles, by which the apparently complex phenomenological behavior of real materials can be interpreted in terms of a few basic concepts, are the laws governing the formation of matter from particles and larger structural elements at different levels of aggregation. Familiarity with the modern physical concepts of atomic structure, of statistical mechanics, and of the basically discontinuous (quantum) nature of all processes of energy transformation is a necessity for the engineer who is attempting to improve his materials and really to understand their properties," page 4.

In line with these opinions the author devotes the first part of the book to acquainting the reader with some of the concepts of theoretical physics: quanta, Bohr's atom model, Pauli's exclusion principle, quantum statistics and "wave particles," thermal oscillators, formation of real materials, and other similar subjects. In view of the author's frequent references to the tasks awaiting mechanical engineers in their professional practice as designers of machines and many of the examples selected as illustrations of applications of his theory of inelastic behavior of engineering materials, which make up the third part of the book, this reviewer assumes that it was primarily conceived as a textbook for engineering students.

The author, who is an engineer, has set himself a difficult task in attempting to fuse together in a treatise of moderate size the abstract principles of modern theoretical physics and the "phenomenological methods" representing, according to the author's expressed views, the system of the theories in engineering mechanics. Granting that he has succeeded in his attempts to permeate the latter with the former ones, it remains questionable whether these efforts will really help to fill the gaps in the defective knowledge of young engineers to which he refers. This reviewer questions seriously the practicability of converting mechanical engineers to the afore-mentioned principles. Would it not be sufficient to call on the theoretical physicist if some complex problems should arise in which his experiences are beneficial, instead of burdening design engineers with the abstract contents of modern physics?

To quote the author again: "The discrepancy between the elaborate analysis in the aerodynamic phase of the design of modern airplanes, or the thermodynamical analysis of the design of gas turbines, and the crudeness of the concepts and methods used in proportioning the parts of such machines, emphasizes the need for a more effective approach to the study of the behavior of real materials." Although, admittedly, the training of mechanical engineers in the fundamentals of mechanics is not as good as it should be, is it not surprising that so many products of the machine industry of the United States have reached that high level of perfection known all over the world, and that airplanes, large steam and gas turbines, electric generators, and other machines built in this country,

excel in performance, reliability, economy, and productive capacity?

The author appears to have preconceived ideas about the ways in which the engineering departments in our large plants operate and does little justice to the spirit which guides responsible design and research in the machine industry. Is it true that engineers are as ignorant about the true behavior of metals beyond the elastic range of strains as the author believes? Any practical engineer could point out that the great turbogenerators in our power stations could not run smoothly and continuously over service periods of 10 to 20 years if their parts had been proportioned "solely in terms of elastic theory." The contrary is the truth.

It is perhaps to the credit of designers and their colleagues in the industrial research laboratories that the true behavior of metals in the plastic and creep range at high temperatures has reliably been determined during recent years in quiet unselfish co-operation and through patient efforts in frequently extremely laborious and difficult experimental investigations. The same is true of those engineers who have developed the theory of plasticity mathematically here and abroad since the time of Saint Venant, including its applications to metal forming, a field in which little may be gained by injecting the principles of theoretical physics.

Obviously, there is a physical, a metallurgical, and a mechanical side to many questions relating to the strength of metallic materials, each of which has its justification and limits of applicability. Had the author, in conceding this fact, delegated a considerable amount of the mechanically less profitable discussions to be found in his book to other specialists competent in adjoining fields, this would have at least simplified his own task.

After admitting the duality in the concepts about matter it seems quite futile to dispute the merits of discontinuous structure versus those of a continuum, both of which offer their characteristic advantages in their respective fields of applicability. The author could have then capitalized more on recent progress made in the theory of plasticity, clearly indicating that matter may still be treated most profitably in most engineering problems as a continuum as it has been considered in hydro- and aerodynamics and in the theory of elasticity. Much unwarranted emphasis, it seems, is placed in this book on forcing mathematically some of the internal structural aspects upon describing certain phenomena of flow and fracture because, as the matter stands, the atomic theory is unable to predict numerically the limiting values of the constants appearing in the equations in the majority of cases, or the limiting flow or fracture stresses.

Certain overgeneralizations such as: "only materials with an identifiable unique geometric pattern such as crystals can be truly elastic . . ." (have glasses not perfect elasticity at low temperatures and fluids perfect volume elasticity?); or that a layer of bubbles floating on a soap solution "represents the behavior of a metal very closely because the bubbles are uniform in size"; and the explanation offered of the delayed fracture in glass upon release of pressure, are misleading.

An inspection of a number of chapters in the latter parts of the book reveals many subjects which have been treated mathematically more completely and with more detail in other books and papers whereas the author picked out mostly the simplest cases as his illustrations of the theory of plasticity.

# Four-Bar Linkage

ANALYSIS OF THE FOUR-BAR LINKAGE: Its Application to the Synthesis of Mechanisms. By John A. Hrones and George L. Nelson. The Technology Press of The Massachusetts Institute of Technology and John Wiley and Sons, Inc., New York, N. Y.; Chapman and Hall, Ltd., London, England, 1951. Cloth, $10^3/_4 \times 17$ in., figs., charts, xx and 730 pp., $15.

REVIEWED BY ALEXANDER W. LUCE[4]

THIS volume brings to machine designers at a trifling cost a wealth of information in readily usable form. Its 730 full-page plates have been machine-made with a five-inch length of driving crank recording full information for five-degree increments of crank travel of the precision machine. More than 7000 mechanisms are analyzed. The photographic reduction only to half size results in a mammoth volume but presents the information in ample size for easy and effective use.

In addition to the 730 plates there are six full-page examples of the use of the trajectories and 14 pages of text including the discussion of the examples. It is pre-eminently a book of deeds rather than words.

The text classifies the four-bar linkage as (*a*) the crank and rocker, where the driving crank makes a full revolution and the follower only oscillates; (*b*) the drag link, where both cranks make complete revolutions; and (*c*) the double rocker, where neither crank is able to make a full turn. The plates are confined to class (*a*) mechanisms.

Plates are presented in sets of five for each of which the length of connecting rod, length of follower crank, and length of fixed center distance are unchanged. These lengths are given in each case as a multiple of the length of the crank. Groups of these sets of five result from varying two of the lengths with each different length of the third. Length ratios vary from 1.5 to 6.0 times the crank length.

In each set of five plates the initial position of the crank is in line with the fixed centers. Each of the five plates includes trajectories of eight to ten different points on the connecting rod located within one crank length of the connecting-rod center line. The points lie along the rod's center line in the third plate of each set and are, respectively, a crank length above and below and half a crank length above and below in the other four plates of the set. Each set also includes the action of the crank and of the follower. A small key drawing on each plate effectively identifies the proportions of the mechanism covered by the plate.

The trajectories have been precisely interrupted every five degrees of crank rotation. Average velocities are obtained readily by dividing increments of trajectory length by the uniform increment of time. Average acceleration may be obtained by treating the increments of trajectory as velocity vectors. The vector difference of any two adjacent vectors gives change in velocity or acceleration.

The authors briefly discuss the commendable accuracy of the trajectories and their usefulness in analysis, and especially in synthesis, of machines. Limitations on the accuracy of the velocity and acceleration determinations are realistically considered. There is a sound presentation for the case for using a linkage instead of a cam in appropriate circumstances.

The illustrative examples include provision of a dwell period in a cycle through utilization of a straight-line portion of a trajectory and also through use of a circular portion of a different trajectory. An example of a computer linkage, a logarithmic motion, a case of one linkage yielding a double oscillation to a secondary follower, and a case of symmetrical motion paths, amply suggest the synthetic possibilities available to designers.

[4] Head, Department of Mechanical Engineering, Pratt Institute, Brooklyn, N. Y. Mem. ASME.

# Books Received in Library

ENGINEERING MATERIALS MANUAL. Edited by T. C. DuMond, and published by *Materials and Methods*, Reinhold Publishing Corporation, New York, N. Y., 1951. Stiff cardboard, $8^1/_4 \times 11^3/_4$ in., 386 pp., illus., diagrams, charts, tables, $4.50. A collection of special sections originally published in the magazine *Materials and Methods*, this book provides descriptive information and reference data on the engineering materials used in industry. Its 28 sections cover such materials as iron, steel, stainless steel, aluminum, magnesium, copper alloys, plastics, rubber, ceramics, and several types of finishes and coatings. Two of the relatively new materials considered are beryllium copper and high-strength low-alloy steels.

FISCHER-TROPSCH AND RELATED SYNTHESES. By H. H. Storch, N. Golumbic, and R. B. Anderson. John Wiley & Sons, Inc., New York, N. Y., Chapman & Hall, Ltd., London, England, 1951. Linen, $6 \times 9^1/_4$ in., 610 pp., illus., diagrams, charts, tables, $9. Of interest to those concerned with new developments in fuels, this book is a detailed summary, documented and critically analyzed, of the work done during the war years in Germany on the synthesis of aliphatic organic compounds by the catalytic hydrogenation of carbon monoxide. Three chapters are devoted to the fundamental aspects of the subject and the remainder of the book to the development of the Fischer-Tropsch and related processes. Original data and references to the sources of information are included.

FOURIER TRANSFORMS. By I. N. Sneddon. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1951. Linen, $6 \times 9^1/_4$ in., 542 pp., diagrams, charts, tables, $10. Suitable for use by those interested in the boundary-value problems of physics and engineering, this book emphasizes the applications of the theory of Fourier transforms and such related topics as Laplace, Mellin, Hankel transforms, finite transforms, dual integral equations, and the Wiener-Hopf procedure. The first three chapters contain basic theory, and the remaining seven are devoted to the illustration of the use of this theory in the theory of vibration, conduction of heat, slowing down of neutrons, hydrodynamics, atomic and nuclear physics, and elasticity.

GAS TURBINES. By H. A. Sorensen. Ronald Press Co., New York, N. Y., 1951. Linen, $6 \times 9^1/_4$ in., 460 pp., illus., diagrams, charts, tables, $6.50. The object of this book is to present a thorough and fundamental treatment of the thermodynamic principles, the elements of design, and the general construction features of the gas turbine. The material is organized by topic or function rather than by type of plant. Special emphasis is placed on the axial-flow compressor and turbine. A knowledge of engineering thermodynamics is required. Treatment of aerodynamics and gas flow is minimized. Operating data are included to indicate current performance.

HEATING, VENTILATING, AIR CONDITIONING GUIDE, vol. 29, 1951. American Society of Heating and Ventilating Engineers, New York, N. Y., 1951. Fabrikoid, $6 \times 9^1/_4$ in., 1456 pp., illus., diagrams, charts, tables, $7.50. A standard reference book, its fifty chapters are devoted to such varied topics as the fundamentals of thermodynamics, the physiological bases of heating and air conditioning, the calculation of heating and cooling loads of enclosed spaces, and to descriptions of systems and apparatus such as steam-heating systems, panel heating, electric heating, refrigeration, and drying systems. The many changes made in this new edition are listed in the preface. There is a large indexed section of condensed manufacturers' catalogs.

INTRODUCTION TO TEXTILE FINISHING. By J. T. Marsh. John Wiley & Sons, Inc., New York, N. Y., 1951. Cloth, $5^1/_2 \times 8^3/_4$ in., 552 pp., illus., diagrams, charts, tables, $5.50. The entire field of finishing is reviewed, covering all textiles, and stressing chemical aspects. The several basic processes are dealt with in a systematic manner and include all operations other than scouring, bleaching, and coloring to which fabrics are subjected after leaving the loom or knitting machine. Separate chapters are devoted to the proofing of fabrics against water, fire, insects, and mildew.

INTRODUCTION TO THE STUDY OF AIRCRAFT VIBRATION AND FLUTTER. By R. H. Scanlan and R. Rosenbaum. The Macmillan Company, New York, N. Y., 1951. Linen, $6^1/_4 \times 7^1/_2$ in., 428 pp., illus., diagrams, charts, tables, $7.50. This book is intended for use by practicing engineers in the field who are not familiar with modern techniques of aircraft dynamics, and also by senior or graduate engineering students in courses in aircraft vibrations. The emphasis is on "classical" questions, e.g., the mechanics of linear structural vibration and the various cases of wing flutter, the air forces for which can be described by potential theory in incompressible air. Compressible-flow results, as well as other advanced material, are included in the appendix. An extensive classified bibliography is also included.

LOCOMOTIVE CYCLOPEDIA OF AMERICAN PRACTICE, 1950–1952. Edited for Association of American Railroads-Mechanical Division, by C. B. Peck and associates. Fourteenth edition. Simmons-Boardman Publishing Corporation, New York, N. Y., 1950. Fabrikoid, $8^1/_2 \times 11^1/_4$ in., 1028 pp., illus., diagrams, charts, tables, $10. The major changes in this standard reference include nine new sections dealing with Diesel-electric locomotives; a revision and trimming to eliminate obsolete data in the sections on steam locomotives; a new section on the gas turbine-electric locomotive; new designs in the all-electric locomotive; inclusion of data on the standard, export, industrial, and mine electric locomotives in one section; and three new sections on Diesel-electric maintenance and servicing. The usual dictionary of locomotive terms is included as well as the extensive technical data.

MATERIALS HANDLING CASE BOOK. Edited by L. K. Urquhart and C. W. Boyce. McGraw-Hill Book Co., Inc., New York, N. Y.; London, England; Toronto, Canada, 1951. Cloth, $8^1/_4 \times 11^1/_4$ in., 440 pp., illus., diagrams, charts, $8. Presenting a selection of articles from *Factory Management and Maintenance*, this book provides 190 specific approaches to materials-handling problems. The articles are arranged in chapters according to where in the plant the problem exists. Three indexes are given listing kind of equipment used, kind of product handled, and company name.

ORDNANCE PRODUCTION METHODS. Edited by C. O. Herb. The Industrial Press, New York, N. Y., 1951. Linen, $8 \times 11$ in., 534 pp., illus., diagrams, charts, tables, $10. This collection of articles, which appeared in the magazine, *Machinery*, during and after World War II, is devoted to preferred manufacturing methods for producing a variety of arms and ammunition. The articles are arranged in ten sections, according to the ordnance items dealt with. Among the topics covered are shells; cartridge cases and tanks; bombs, rockets, and torpedoes; machine guns and small arms; artillery, antiaircraft and naval guns; gun mounts; and general ordnance manufacturing.

PLANT LAYOUT. By J. A. Shubin and H. Madeheim. Prentice Hall, Inc., New York, N. Y., 1951. Cloth, $6 \times 9^1/_4$ in., 433 pp., illus., diagrams, charts, tables, $7.35. Written for students of engineering and management, this book considers the principles, techniques, and procedures connected with the selection and layout of plant facilities. It discusses economic change and growth, the characteristics of industrial processes, plant location, product design, technological advance, and equipment-replacement problems. Materials-handling and building considerations are discussed in separate chapters. Review questions are included at the end of most of the chapters.

PRINCIPLES AND METHODS OF SHEET-METAL FABRICATING. By G. Sachs. Reinhold Publishing Corporation, New York, N. Y., 1951. Cloth, $6 \times 9^1/_4$ in., 526 pp., illus., diagrams, charts, tables, $10. Of interest to mechanical engineers and metallurgists, this book systematically describes the principles of the numerous sheet-metal-forming methods, emphasizing their similarities and differences. It covers the theory of deformation of sheet metal and tubing, the metallurgical effects produced by various procedures, the practical operations involved, the design of parts and dies, and the production equipment used. Numerous examples of commercial work are given and analyzed.

PRODUCTION FORECASTING, PLANNING, AND CONTROL. By E. H. MacNiece. John Wiley & Sons, Inc., New York, N. Y., Chapman & Hall, Ltd., London, England, 1951. Linen, $6 \times 9^1/_4$ in., 305 pp., illus., diagrams, charts, tables, $5.50. Of use to both students and executives, this book is devoted to basic principles. It explains how these principles are applied in many departments of industrial organizations. Some specific examples of effective applications are included. Balancing a consideration of the subject from an engineering viewpoint are treatments of economic and sonal implications. Problems and questions follow each chapter and a bibliography is given.

PRODUCTION OF MOTOR VEHICLES. By H. M. Cunningham and W. F. Sherman. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1951. Linen, $6 \times 9^1/_4$ in., 169 pp., illus., diagrams, charts, tables, $3.50. A guide to managerial techniques in the planning, scheduling, manufacturing, and distributing of motor vehicles, this book studies the successive steps required to plan and produce a new model automobile or truck. The practices, procedures, methods, job descriptions and titles, and time elements discussed are based on a cross section of the truck and automobile industry. No attempt has been made to present descriptive material covering all of the many detailed operations of automotive production.

PROPERTIES OF LUBRICATING OIL AND ENGINE DEPOSITS. By C. A. Bouman. Macmillan and Co., New York, N. Y., and London, England, 1950. Cloth, $5^1/_2 \times 8^3/_4$ in., 170 pp., diagrams, charts, tables, $3. After a few brief chapters on the purposes of lubrication, classification of lubricating oils, and manufacture of lubricating oils, the author discusses at greater

length such items as: viscosity, friction, volatility, oil consumption, cylinder wear, contamination, sludge deposits, carbon deposits, lacquer deposits, piston-ring sticking, maintenance, and testing of oils.

QUANTUM MECHANICS OF PARTICLES AND WAVE FIELDS. By A. March. John Wiley & Sons, Inc., New York, N. Y., Chapman & Hall, Ltd., London, England, 1951. Linen, 6 × 9 1/4 in., 292 pp., diagrams, charts, $5.50. Intended for use by those without previous knowledge of the subject, this book covers both the quantum mechanics of wave fields and the older quantum theory of particles. Emphasis is on a clear understanding of the principles involved. The final chapter presents a revolutionary theory of fundamental length, a theory designed to meet some of the basic difficulties still present in the quantum theory.

SCHOLARSHIPS, FELLOWSHIPS AND LOANS, volume 2. By S. N. Feingold. Bellman Publishing Co., Boston, Mass., 1951. Cloth, 6 1/2 × 9 3/4 in., 312 pp., $5. This second volume devoted to sources of student-aid funds includes further material in this field. It lists additional administering agencies, more bibliographical references, stresses examples of financial assistance that may be available at a local level, data on State scholarships, more material in the section on career planning, and covers more vocational goals. The same general procedure as in volume 1 is followed, but instructions are given in greater detail.

STRENGTH OF MATERIALS. By M. M. Frocht. Ronald Press Co., New York, N. Y., 1951. Linen, 6 × 9 1/4 in., 439 pp., illus., diagrams, charts, tables, $5.50. Based on the previous "Strength of Materials" published jointly with the late Prof. N. C. Riggs, this book serves as a text for a first course dealing primarily with basic types of materials failure and their prevention. An unusual feature is the new approach to the subject via statically determinate problems, coupled with the emphasis on the significance of the stresses. Problems are chosen for their technical relevance and answers to many are supplied at the end of the book.

TABLE OF ARCTANGENTS OF RATIONAL NUMBERS. (Applied Mathematics Series 11.) By J. Todd. U. S. Bureau of Standards, Washington, D. C., 1951. Cloth, 8 × 10 1/2 in., 105 pp., tables, $1.50, for sale by Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Table 1, in addition to $m^2 + n^2$ and arctan $(m/n)$, also gives arccot $(m/n)$. The angles are expressed in radians to 12 decimals and complete reductions of arctan $(m/n)$ are given for $0 < m < n \leq 100$. Table 2 gives a list of those integers $n$ not exceeding 2089 for which arctan $n$ is reducible and the corresponding complete reductions.

TIME BASES (Scanning Generators), Their Design and Development with Notes on the Cathode Ray Tube. By O. S. Puckle. Second edition, revised. John Wiley & Sons, Inc., New York, N. Y., 1951. Cloth, 387 pp., illus., diagrams, charts, tables, $5. This book is devoted to the principles of design, construction, testing, and applications of scanning generators. This second edition contains an additional 150 pages covering significant wartime and postwar developments. A new chapter is added on Miller capacitance time bases. Additions and revisions have been made in nearly every section. There now are eight appendixes on specialized aspects and eighteen useful tables of data.

THERMODYNAMICS OF FLUID FLOW. By N. A. Hall. Prentice-Hall, Inc., New York, N. Y., 1951. Linen, 5 3/4 × 8 3/4 in., 278 pp., diagrams, charts, tables, $7.35. This book is concerned with the combined application of the principles of fluid mechanics and thermodynamics in the analysis of fluid flow. Major emphasis is on theory with examples to demonstrate its applications. In handling fluid-flow problems, the author assumes that the flow is both steady and one-dimensional. Although organized as a text, the book provides reference material for those engaged in research and development in jet propulsion, process industry, and other fluids dependent on flow systems.

DIE TRAGFÄHIGKEIT DER ZAHNRÄDER. By A. K. Thomas. Carl Hanser Verlag, Munich, Germany, 1950. Paper, 5 3/4 × 8 1/4 in., 175 pp., diagrams, charts, tables, 12 Dm. This book, based on practical needs and experiences in the drafting room, is useful in the calculation of individual gears and gear mechanisms. It contains detailed discussions of the calculations used to determine the load capacity of spur, bevel, worm, and helical gears. Procedures employing geometrical analysis are also included. Numerous figures and tables illustrate the text.

ULTRASONICS. By P. Vigoureux. John Wiley & Sons, Inc., New York, N. Y., 1951. Linen, 6 × 10 in., 163 pp., illus., diagrams, charts, tables, $4. This book serves as an introduction to the technique and to the simpler aspects of the theory of propagation of ultrasonics in fluids. The general principles of apparatus and of experimental procedures are stressed rather than details. The theoretical treatment is kept as simple as possible. References to the literature published since January 1, 1939, are given in the thirteen-page bibliography.

VECTOR REPRESENTATIONS OF DIFFERENTIAL EQUATIONS, THEIR SOLUTIONS AND THE DERIVATIVES THEREOF. By A. H. Boerdijk, Delft, Netherlands Bibliotheek der Technische Hoogeschool. Published by Waltman, Hippolytusbuurt 4–6, Delft, Holland, 1951. Paper, 6 1/4 × 9 1/2 in., 177 pp., diagrams. In this thesis extensions of common vector diagrams related to a general linear equation are dealt with. In the case of nonhomogeneous differential equations the application on the diagrams is restricted to certain forcing functions. Application of the diagrams to various electrical and mechanical systems is briefly demonstrated.

WORLD RESOURCES AND INDUSTRIES. By E. W. Zimmermann. Revised edition, Harper & Brothers, New York, N. Y., 1951. Linen, 7 1/4 × 10 1/2 in., 832 pp., illus., diagrams, charts, maps, tables, $7.50. This comprehensive book provides a functional appraisal of the availability of agricultural and industrial materials. The section on industrial resources gives specific information and statistics on various groups of materials and products of which a few are coal, petroleum, natural gas, electricity, iron and steel, copper, light metals, and chemicals. Conservation and adequacy of resources are considered. Many bibliographical references are included.

# ASME BOILER CODE

## Interpretations

THE Boiler Code Committee meets monthly to consider "Cases" where users have found difficulty in interpreting the Code. These pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler Code Committee, ASME, 29 West 39th Street, New York 18, N. Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) They are submitted to the Board for action; (5) Those approved are sent to the inquirers and are published in MECHANICAL ENGINEERING.

(The following Case Interpretations were formulated at the Committee meeting July 27, 1951, and approved by the Board, August 24, 1951.)

### CASE No. 1142

*(Special Ruling)*

*Inquiry:* Will unfired pressure vessels embodying 90-10 copper nickel tubing in accordance with Specification SB-111 be acceptable under the Code? If so, what stresses are to be used?

*Reply:* It is the opinion of the Committee that the use in unfired pressure vessels of 90-10 copper nickel condenser tubing conforming to Specification SB-111 will meet the intent of the Code.

The maximum allowable design stresses shall be as follows, provided that the wall thickness used shall be such that the stress in the tube during the hydrostatic test shall not exceed 15,000 psi:

For metal temperature not exceeding deg F

| 150 | 250 | 300 | 350 | 400 |
|---|---|---|---|---|
| 10,000 | 9,500 | 9,300 | 9,000 | 8,700 |

| 450 | 500 | 550 | 600 |
|---|---|---|---|
| 8,300 | 7,500 | 6,700 | 6,000 |

### CASE No. 1143

*(Special Ruling)*

*Inquiry:* May the proposed revisions published in August, 1951 issue of MECHANICAL ENGINEERING be used for pipes and tubes?

*Reply:* Since corrections to the proposed revisions have been editorial, the use of the revisions given below for pipes

and tubes will meet the intent of the Code.

NOTE: The revisions referred to are omitted here having been published on pages 672 and 673 of the August issue of MECHANICAL ENGINEERING. Included were revision to Tables P-2, P-3, P-4, P-5, and P-7 on pages 674, 675, and 676, to which should be made the following changes:

In Appendix 2 on Page 676, Recommended Stresses for Tables P-5 and P-7, Alloy Steels, third line from the bottom, Specifications SA-158, Type P5c and SA-213, Type T-14, under Temperature 1200 F, revise stress to read "1200."

Under Austenitic Alloys, revise stresses to read:

| Material | 950 | 1000 | 1050 |
|---|---|---|---|
| 16 Cr 13 Ni 3 Mo | 15,100 | 14,000 | 12,200) |

## Proposed Revisions and Addenda to Boiler Construction Code

AS need arises, the Boiler Code Committee entertains suggestions for revising its Codes. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the annual addenda supplements to the Code. Triennally the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code. Simple changes are indicated directly. In the more involved revisions added words are printed in SMALL CAPITALS; deleted words are enclosed in brackets [].

Comments should be addressed to the Secretary of the Boiler Code Committee, ASME, 29 West 39th Street, New York 18, N. Y.

### Unfired Pressure Vessels 1950

PAR. U-1(e). Delete and substitute:

(e) Unfired pressure vessels that do not exceed the following volume and pressure limits:

(1) 5 cu ft in volume and 250 psi design pressure;

(2) $1^1/_2$ cu ft in volume with no limit on pressure; may be exempted from compliance with the requirements for inspection given in Pars. UG-90 through UG-97, provided that they comply in all other respects with the requirements of this Code, except as otherwise permitted in (d).

Vessels exempted from Code inspection by this rule shall be marked with the UM symbol in Fig. UG-116(b) and with the data required in Par. UG-116. A certificate for vessels exempted from Code inspection shall be furnished by the fabricator on Form U-3 when required. In an assembly of vessels the limitations in (1) and (2) apply to each vessel and not to the assembly as a whole.

PAR. U-2(a). Delete and substitute:

U-2(a) The fabricator of an unfired pressure vessel that is to be marked with the Code U symbol or UM symbol shall construct the vessel in accordance with the requirements of this Code. The inspector shall make such inspections of vessels to which he authorizes the application of the Code U symbol as he believes are required in order to certify that the vessel has been constructed in accordance with the requirements of the Code.

PAR. UG-90. Delete entire paragraph and substitute:

UG-90 *General* (a) The inspection and testing of unfired pressure vessels to be marked with the Code U symbol and the testing of vessels to be marked with the Code UM symbol shall conform to the general requirements in the following paragraphs and in addition to the specific requirements for Inspection and Tests given in the applicable parts of Subsections (b) and (c).

(b) The fabricator who completes any vessel to be marked with the Code U symbol or UM symbol has the responsibility of complying with all the requirements of the Code, and through proper certification of assuring that any work done by others also complies with all the requirements of the Code.

(c) The inspector of vessels to be marked with the Code U symbol has the duty of making such inspections as he considers are necessary in order to satisfy himself that all the requirements of the Code have been met (See Pars. UW-46, UR-50).

PAR. UG-97. Delete entire paragraph and substitute:

UG-97 *Inspection During Fabrication* (a) The inspector shall make inspections of each pressure vessel at such stages of construction as he deems are necessary to assure himself that fabrication is in accordance with Code requirement (See Pars. UW-48, UR-51).

(b) When conditions permit entry into the vessel, as complete as possible internal inspection shall be made before final closure.

(c) It is recommended that an inspection be made at the time of the hydrostatic test or its permissible equivalent.

PAR. UG-116(a)(1). Delete and substitute:

(1) Official Code symbol shown in Fig. UG-116

(*a*) The U symbol shown in Fig. UG-116 shall be used for vessels inspected in accordance with the requirements in Pars. UG-90 through UG-97. The word "USER" shall be stamped above the U symbol when the vessel is inspected by the user's inspector as provided in Par. UG-91.

(*b*) The UM symbol shown in Fig. UG-116 shall be used for vessels not inspected in accordance with the requirements in Pars. UG-90 through UG-97 as permitted in Par. U-1(e).

PAR. UG-116(g). Delete and substitute:

(g) The fabricator who completes the vessel shall apply the Code symbol and must have a certificate of authorization for its use. The Code U symbol shall be applied in the presence and with the approval of the inspector after the hydrostatic test or its permissible equivalent has been made. The UM symbol shall be applied after the vessel has passed the hydrostatic test or its permissible equivalent. The application of the Code symbol shall indicate that all Code requirements have been met.

PAR. UG-116(m)(1). Revise first sentence to read:

Any fabricator of unfired pressure vessels may apply to the Boiler Code Committee of the Society, upon forms issued by the Society, for permission to use either or both stamps.

PAR. UG-120(a). Delete and substitute:

UG-120 *Data Reports* (a) *Single Units.* A data report shall be filled out on Form U-1 by the fabricator and shall be signed by the fabricator and inspector for each pressure vessel marked with the Code U symbol. When required, a certificate of compliance on Form U-3 shall be filled out and signed by the fabricator for each pressure vessel marked with the Code UM symbol.

PAR. UW-51(m). Delete and substitute:

(m) Sections of welds that are shown by radiography to have any of the following types of imperfections shall be judged unacceptable and shall be repaired as provided in Par. UW-38.

(1) Any type of crack or zone of incomplete fusion or penetration;

(2) Any elongated inclusion which has a length greater than

$^1/_4$ in. for $T$ up to $^3/_4$ in.
$^1/_3T$ for $T = {}^3/_4$ in. and up to $2^1/_4$ in.
$^3/_4$ in. for $T = 2^1/_4$ in. and over

where $T$ is the thickness of the thinner plate being welded;

(3) Any group of slag inclusions in line that have an aggregate length greater than $T$ in a length of $12T$, except when the distance between the successive imperfections exceeds $6L$ where $L$ is the length of the longest imperfection in the group;

(4) Porosity in excess of that shown as acceptable by the standards attached.*

* NOTE: These Standards may be obtained by inquiry at the office of the Boiler Code Committee.

FORM U-3. Revise title to read:

Form U-3 MANUFACTURERS' CERTIFICATE OF COMPLIANCE COVERING UNFIRED PRESSURE VESSELS TO BE STAMPED WITH THE UM SYMBOL [See Par U-1(e)]

# THE ENGINEERING PROFESSION

## *News and Notes*

As Compiled and Edited by A. F. Bochenek

## Postcollege Industrial Training Concern of ECPD at 1951 Annual Meeting

### *Headquarters: Hotel Statler, Boston, Mass., Oct. 19–20*

PANEL discussions on training and upgrading of young engineers and on what guidance agencies on the regional, state, and community levels can do to help in the engineering manpower situation will be features of the 19th annual meeting of the Engineers' Council for Professional Development to be held at the Statler Hotel, Boston, Mass., Oct. 19–20, 1951.

The ECPD is a conference body organized to enhance the professional status of the engineer through the co-operative efforts of major professional engineering societies. ECPD annual meetings are held in various cities of the nation to permit industrialists and others concerned with engineering training to meet with representatives of professional societies and engineering schools.

#### NCSBEE Annual Meeting to Follow

The ECPD annual meeting will precede the 30th annual meeting of the National Council of State Boards of Engineering Examiners, which will also be held at the Hotel Statler in Boston, Oct. 21–24, 1951.

The first public event of the ECPD meeting will be a luncheon on Friday, Oct. 19, during which Harold B. Richmond, chairman of the board, General Radio Company, Cambridge, Mass., will talk on "Observations on Co-Operative Course Training as Viewed by a Manufacturer."

#### Professional Training

Of particular interest to industry, currently faced with an imposing engineering manpower shortage, will be the panel discussion sponsored by the ECPD Committee on Professional Training, of which A. C. Monteith, vice-president in charge of engineering and research, Westinghouse Electric Corporation, Pittsburgh, Pa., is chairman. The panel will cover the ECPD six-point program for development of a professional man which includes (1) orientation and training of the young engineer, (2) continued education of engineering graduates, (3) integrating the young engineer into his community, (4) registration of the young engineer, (5) self-appraisal methods for valuable characteristics in engineering, and (6) selected reading for professional development. Speakers will tell how each of these phases of the program was introduced into typical urban areas.

The same theme will be carried further during the ECPD annual banquet on Friday with E. W. O'Brien, past-president ASME, who will talk on "What Junior Engineers Find Important." Under Mr. O'Brien's encouragement the National Junior Committee of the ASME was organized in 1947 and has since developed a program in the Society for younger engineers.

#### Counseling

On Saturday morning, Oct. 20, the meeting will be devoted to a discussion of student guidance. The panel will be sponsored by the ECPD Guidance Committee which has been inquiring into the present status of local guidance activities. This committee has conducted a survey of 450 engineering groups organized on the local level to determine extent and nature of guidance work being done. Its objective is to co-ordinate the guidance activities on national, state, and community levels.

As part of its program the committee has revised its Guidance Manual to aid high-school guidance officers and engineers doing guidance work.

This theme will be continued at the luncheon on Saturday when James R. Killian, Jr., president, Massachusetts Institute of Technology, Cambridge, Mass., will speak on "Student Counseling in an Engineering School."

H. S. Rogers, chairman, ECPD, will address the annual dinner of the NCSBEE.

Albert Haertlein, professor of civil engineering, Harvard University, Cambridge, Mass., is chairman of the local arrangements committee. Co-operating in the program, in addition to constituent ECPD societies, will be the Boston Society of Civil Engineers and the New England Association of Engineering Societies.

## D. C. Jackson Memorial Service

A MEMORIAL service for the late Prof. Dugald C. Jackson, Hon. Mem. ASME and AIEE, will be held at The First Congregational Church, 11 Garden Street, Cambridge, Mass., Sunday, Oct. 11, 1951, at 4:00 p.m.

Friends attending the 19th Annual meeting of The Engineers' Council for Professional Development and the 30th annual meeting of the National Council of State Boards of Engineering Examiners are invited to attend the memorial services.

## Engineers Joint Council Joins UPADI

ENGINEERS Joint Council has received the approval of a majority of its member bodies to become an adherent of the Pan-American Union of Engineering Societies, known as UPADI from its Spanish name, *Union Panamericana de Asociaciones de Ingenieros.*

Engineers Joint Council has given enthusiastic support to the concept of a Pan-American organization since its origin and participated in the first steps of its formation taken at Rio de Janeiro in July, 1949, when the representatives of engineering societies in the Americas met in a First Pan-American Engineering Congress. UPADI held its first meeting in Havana in 1951 and agreed on a draft Constitution which was to govern until the next meeting to be held in New Orleans—now scheduled for the late summer of 1952.

The United States delegates to Havana, under the chairmanship of Adolph J. Ackerman, consisted of Fred Agthe, W. N. Carey, W. H. Carson, Gail A. Hathaway, Titus G. Le Clair, S. E. Reimel, James M. Todd, S. L. Tyler. Also present and helpful at the convention were S. S. Steinberg, as adviser to ASCE delegates, and Harry R. Kessler, vice-president ASME, and A. M. Lederer. The Canadian delegates, J. A. Vance and L. Austin Wright, president and secretary of The Engineering Institute of Canada, co-operated fully.

The United States is one of nine nations designated to furnish a member to the first UPADI Board of Directors. James M. Todd, past-president ASME, has been appointed as the U. S. member of the UPADI Board, and S. L. Tyler will represent the U. S. A. on the permanent UPADI Committee on Constitution and By-Laws.

Acting upon the invitation of the U. S. delegates, the Havana UPADI convention decided to hold its next convention at New Orleans, La. during the late summer of 1952. This will permit delegates from other countries to take advantage of the trip to the U. S. to attend the Centennial of Engineering in Chicago immediately following.

## Better Collaboration Among Design Professions Sought

A DRAFT of a document defining a division of responsibility of architects, city planners, civil engineers, landscape architects, mechanical and electrical engineers, and others involved in design of housing and government, was approved in principle by the Council of

The American Society of Mechanical Engineers after careful study and revision.

The statement was the work of the Joint Committee of the Design Professions sponsored by the American Institute of Architects. Ten other national technical organizations were represented on the joint committee. S. Logan Kerr, consulting engineer, Philadelphia, Pa., represented the ASME.

According to the document, efficient collaboration among design professions should begin at the earliest stage of a construction project. This collaboration can be effective only when respective responsibilities are clarified and when a code of ethics guides decisions of the representatives of the various professions.

On construction projects involving more than one design profession, the collaborator having "the greatest responsibility or experience in directing the particular type of project involved" should be chosen project co-ordinator, the document states. Allocation of professional responsibility should be determined before the start of design services at a joint conference of members of the collaborating professions.

When completed the document will be composed of five parts in addition to the introductory general policy statements. Only part 1 dealing with housing, institution, and government-building construction is completed. In preparation are sections on airfields, industrial projects, mechanical-engineering projects, and civil-engineering projects.

## Corrosion Resistance Program Sponsored by AWS

A TEST program to determine the corrosion resistance of steel having metallized coatings of zinc and aluminum under exposure to different atmospheres, is being sponsored by The American Welding Society's Committee on Metallizing.

Duplicate steel specimens will be sprayed with aluminum and zinc coatings varying in thickness from 0.003 to 0.015 in., with and without vinyl cover coats.

Preparation of the more than 4000 specimens to be exposed is already under way. When the specimens are completed early this fall, they will be assembled for exposure at such standard corrosion-test sites as those at Kure Beach, N. C.; Point Reyes, Calif.; Gulf Coast; New York, N. Y.; and Wrightsville, N. C. Exposure will be for periods of one, three, six, and twelve years.

The test program is intended to provide authoritative data on what thickness of zinc or aluminum to use for different exposures for various lengths of time.

The types of exposure include sea water, marine atmosphere, and different industrial atmospheres.

Arrangements will be made for examination of exposed specimens at regular intervals and for issuance of periodic reports. Anyone interested in securing a copy of the program or progress reports when issued should write to Secretary, AWS Committee on Metallizing, American Welding Society, 33 West 39th Street, New York 18, N. Y.

# Glossary One of Many ASME Projects in Nuclear-Energy Application

## *Industry to Participate in AEC Developmental Work*

A GLOSSARY of terms in nuclear science and technology will be completed in 1952, it was reported at a meeting of the Nuclear Energy Application Committee of The American Society of Mechanical Engineers held recently in New York, N. Y.

The glossary represents six years of work by the ASME and 20 other scientific and engineering organizations. In 1946 the ASME began work on the project to serve mechanical engineers interested in advancing peacetime application of nuclear energy. The Society soon learned that 20 other groups were planning similar glossaries in chemical, biological, metallurgical, and other fields. The National Research Council called a conference in 1948 to unite the various working groups. Because of the Society's progress on a comprehensive glossary, the ASME was invited to assume administrative responsibility for an over-all project under NRC sponsorship.

### Glossary in Nine Sections

Some of the organizations active in the project are: American Chemical Society; American College of Radiology; American Medical Association; Atomic Energy Commission; Public Health Service; and other engineering and scientific societies.

Manuscripts of the last four of nine sections of the glossary will soon be delivered to the printer. Four of the sections: III, Reactor Engineering; V, Chemical Engineering; VI, Biophysics and Radiobiology; and VII, Instrumentation, have been released in preliminary editions as booklets. Each booklet includes the index of terms to appear in all other sections. Eventually the glossary will be published in book form. Sections yet to be released are: I, General Terms; II, Reactor Theory; IV, Chemistry; VIII, Isotopes Separation; and IX, Metallurgy. The glossary may be ordered from ASME, 29 West 39th Street, New York 18, N. Y. Prices range from 60 cents to $1 per section depending on the number of pages.

A. D. BAILEY, PAST-PRESIDENT ASME, CHAIRMAN OF THE ASME NUCLEAR ENERGY APPLICATION COMMITTEE SINCE 1946

### Other Services

The beneficent application of nuclear energy became a concern of the ASME Council shortly after Aug. 6, 1945, when President Truman announced the first use of the atomic bomb. In January, 1946, appointment of a Nuclear Energy Committee was authorized "to stimulate and develop a continuing program of Society activity dealing with the application of nuclear energy."

During the legislative stages of the Atomic Energy Commission the ASME was instrumental in conveying to legislators, engineering opinions on civilian control of atomic energy and the importance of industrial participation in nuclear developments. Authorities such as Senator Brien McMahon and David E. Lilienthal were invited by the Committee to address the Society during national meetings.

Working closely with staff members of the Atomic Energy Commission, the Society was able to help in the formation of an AEC Industrial Advisory Commission by suggesting a list of names of engineers qualified for this duty. The report of this Group was published on pages 205–212 of the March, 1949, issue of Mechanical Engineering.

Early in 1949 the Committee launched a major effort toward securing better working relations between industry and the Atomic Energy Commission. A threefold program was designed (1) to conduct concentrated classified courses for selected industrial executives and engineering leaders; (2) to promote on-the-job training for working-level engineers loaned to AEC laboratories by companies participating in Part I of the program; and (3) to establish a procedure by which engineering information not essential to security could be declassified for discussion and use by engineers.

Several months were devoted to developing a detailed educational program. The program, however, was finally rejected by the Commission because Part I would entail release of classified information to individuals not actually employed by the AEC.

### Industry-AEC Co-Operation

The work of the ASME Committee, however, was not in vain. A procedure for declassification of engineering information has been established by the AEC with the help of a committee of editors on which the ASME is represented. The Commission is also operating a school for selected industrial engineers and graduate students at which classified information on reactor technology is included in the curriculum. But most promising are the recent contracts between the AEC and industrial organizations which indicate that the Commission is bringing industry directly

## Meetings of Other Societies

**Oct. 8–12**
National Safety Council, 39th national safety council and exposition, Stevens Hotel, Chicago, Ill.

**Oct. 13–14**
American Society for Metals, annual seminar, Hotel Statler, Detroit, Mich.

**Oct. 15–19**
The 33rd Annual Metal Show and 1951 National Metal Congress and Exposition, Detroit, Mich. Exhibits: Michigan State Fair Grounds. Sponsors' headquarters: American Society for Metals, Statler; American Welding Society, Book-Cadillac; Metals Branch, American Institute of Mining and Metallurgical Engineers, Detroit-Leland; and Society for Non-Destructive Testing, Statler.

**Oct. 15–20**
American Institute of Mining and Metallurgical Engineers, fall meeting, Del Prado Hotel, Mexico City, D. F., Mex.

**Oct. 19–20**
Engineers' Council for Professional Development, 19th annual meeting, Hotel Statler, Boston, Mass.

**Oct. 20–24**
American Society for Metals, national metal congress and exposition, Benjamin Franklin Hotel, Philadelphia, Pa.

**Oct. 21–24**
National Council of State Boards of Engineering Examiners, 30th annual meeting, Hotel Statler, Boston, Mass.

**Oct. 22–26**
American Institute of Electrical Engineers, fall general meeting, Cleveland Hotel, Cleveland, Ohio

**Oct. 22–25**
American Society of Civil Engineers, New York convention, Hotel Statler, New York, N. Y.

**Nov. 1–2**
Society for the Advancement of Management, annual conference, Hotel Statler, New York, N. Y.

**Nov. 5–7**
National Academy of Sciences, autumn meeting, Yale University, New Haven, Conn.

**Nov. 5–8**
American Petroleum Institute, 31st annual meeting, Stevens Hotel and Palmer House, Chicago, Ill.

**Nov. 8–9**
American Management Association, Production Division conference, Palmer House, Chicago, Ill.

(*For ASME Calendar of Coming Events see page 861*)

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into the developmental work of the AEC. This program will include design, construction, and operation of a power-producing reactor; economic and technical aspects of reactor construction in the next few years; preliminary research and development work; and recommendations to the AEC on industry's role in the reactor project.

### Eight Organizations Active

Already participating in the program are the Monsanto Chemical Company with its associate, The Union Electric Company, St. Louis, Mo.; The Commonwealth Edison Company and the Public Service Company of Northern Illinois, Chicago, Ill.; The Detroit Edison Company and the Dow Chemical Company of Midland, Mich.; and the Pacific Gas and Electric Company and Bechtel Corporation of San Francisco, Calif.

The latest suggestion taken under consideration by the ASME Committee is the preparation of "packages" containing useful information on various phases of nuclear-energy developments to speed up dissemination of new information.

### The Committee

Members of the Committee are: A. D. Bailey, vice-president, Commonwealth Edison, Chicago, Ill.; W. L. Cisler, executive vice-president, The Detroit Edison Company, Detroit, Mich.; J. R. Dunning, dean of engineering, Columbia University, New York, N. Y.; J. J. Grebe, research counselor, Dow Chemical Company, Midland, Mich.; J. A. Hutcheson, vice-president, Westinghouse Research Laboratories, East Pittsburgh, Pa.; Maj. Gen. K. D. Nichols, Special Weapons Project, Department of the Army, Washington, D. C.; G. B. Pegram, vice-president, Columbia University, New York, N. Y.; Adm. T. A. Solberg, formerly chief of naval research, Washington, D. C.; W. I. Westervelt, Brigadier General, U. S. A. (Retired), Ross & Company, New York, N. Y.; and H. A. Winne, vice-president, charge of engineering policy, General Electric Company, Schenectady, N. Y.

## NSPE Announces Public Relations Program

THE National Society of Professional Engineers recently announced a public-relations program, one of whose objectives is "to inform employers and clients of engineers as to the value of the professional engineer and the meaning of professionalism."

The basis of the program will be a series of questionnaires on such subjects as how to improve engineering-management communication, how to use engineering talent to better advantage, how to attract qualified engineers, and how to train engineers in industry.

The questionnaire will be distributed by NSPE headquarters, state society chapters, and individual members, to employers of engineers who will be invited to answer questions.

The end result of the program will be a series of reports summarizing replies to the questionnaire. These will be bound and distributed to employers of engineers co-operating in the surveys.

## Thermocouple Calibration Tables Subject of West Coast Meeting

IF the military services accept the new A1 calibration tables for iron-constantan thermocouple wire recently prepared by the National Bureau of Standards, temperature-instrument manufacturers and users would be willing to discontinue use of the Leeds and Northrup 1913 tables and the National Bureau of Standards RP–1080 tables now in common usage.

This was the consensus of the symposium sponsored jointly by the Aviation Instrument Committee of the Industrial Instruments and Regulators Division of The American Society of Mechanical Engineers and the Institute of the Aeronautical Sciences. The symposium was held on June 18, 1951, in the IAS building, Los Angeles, Calif.

### Two Standards Now in Use

According to D. K. Warner, chairman of the sponsoring committee, of the two basic standards now in use, industrial and process-equipment users have standardized on equipment calibrated to the Leeds and Northrup 1913 tables, whereas the military services and some of the aircraft manufacturers have standardized on equipment calibrated to the Bureau of Standards RP–1080 tables.

The need for one generally acceptable standard led the National Bureau of Standards to an investigation which resulted in a new set of calibration tables for iron-constantan thermocouples.

These tables more nearly represent the calibration actually obtained from wire which is generally available now. These tables are being incorporated in a proposed NBS standard A1.

According to Mr. Warner, general discussion at the symposium indicated that if the military services should not accept the A1 standard, the alternative choice would be to retain two standards in the industry; the RP–1080 standard for military users and the A1 thermocouple standard for all others. It was clear, however, that the ultimate goal would be universal acceptance of the A1 calibration curve.

The discussion panel consisted of the following: R. L. Fine, project engineer, air development force, Wright-Patterson Air Force Base; H. D. Alexander, field engineer, Lewis Engineering Corporation; P. A. Dennis, chief of engineering laboratory, Douglas aircraft Corporation, El Segundo Division; T. L. McNeely, flight test engineer, North American Aviation, Inc.; M. D. Pugh, Instrument Society of America.

Among the topics covered were the temperature - emf relationship for iron-constantan thermocouples, advantages and disadvantages of the proposed military specification MIL-W-5845A, and such other aspect as accuracy of calibration, selection of wire gages, type of insulation, and color coding.

### Symposium Idea Favored

The symposium was one of a series of meetings arranged jointly by the ASME and IAS to bring together a cross section of thought on a subject of great importance to a small group.

According to Burnie M. Craig, secretary of the IIRD Aviation Instruments Committee, the success of the symposium was attributed in part to a "premeeting get-together" at which speakers received copies of a suggested agenda with various graphs and tables. The same material was also handed to members of the audience.

## Eleventh Book Released in Monographs Series

BY arranging for the publication of the book, "Hydraulic Transients," the Engineering Societies Monographs Committee has made available to engineers for the first time in 25 years an adequate English work in the field of water hammer and surge-tank design.

Written by George R. Rich, Mem. ASME, member of the consulting firm, Charles T. Main Inc., Boston, Mass., the book contains in addition to results of Mr. Rich's original studies, a compilation of existing knowledge on the subject presented in a manner to make it useful to the practicing engineer.

### Book to Fill Need

Mr. Rich's book supplements two French books, one by Alliévi and the other by Calame and Gaden, both twenty-five or more years old, and the ASME "Symposium on Water Hammer" published in 1933, which have been among the most-used references in this field.

"Hydraulic Transients" is the eleventh book issued in the Engineering Societies Monographs Series, which is made possible by the co-operative action of the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, American Institute of Electrical Engineers, United Engineering Trustees, Inc., Engineering Societies Library, and the McGraw-Hill Book Company, Inc.

Since 1931 these organizations have had an agreement for the production of a series of selected books adjudged to possess usefulness for engineers and industry.

The Engineering Societies Monographs Committee was set up to provide monographs of high technical quality within the field of engineering; to rescue from obscurity important technical manuscripts which might not be published commercially because of too limited sale without special introduction; to develop manuscripts to fill gaps in existing literature; to collect into one volume scattered information of special timeliness on a given subject.

### Mongraphs Committee

The Engineering Societies Monographs Committee is composed of two representatives each from the American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, and the American Institute of Electrical Engineers. The director of the Engineering Societies Library acts as chairman of the Committee. The committee at the time of publication of the current volume consisted of: ASCE, Howard T. Critchlow, H. Alden Foster; ASME, John M. Lessells, George R. Rich; AIME, Francis B. Foley, Reed W. Hyde; and AIEE, Ward F. Davidson, Walter I. Slichter. Ralph H. Phelps is chairman.

In accordance with the agreement Mr. Rich's 260-page book is being published by the McGraw-Hill Book Company, New York, N. Y. Price per copy is $6. Copies may be obtained from ASME order department, 29 West 39th Street, New York, N. Y.

## 1952 ASME Mechanical Catalog and Directory

THE forty-first annual ASME Mechanical Catalog and Directory, 1952 edition, was being distributed to ASME members when we went to press.

To build this book new each year requires months of work. Suppliers of mechanical equipment must be canvassed for descriptions of equipment, new and old. They are approached too for lists of products for the directory, new and old. Headings are under scrutiny at all times and by suggestions from members and by developments in industry, revisions in phraseology are incorporated to make the volume more serviceable.

New freshly cast type is used each year to make for ease in reading. Proofs are carefully checked by many people to provide for accuracy.

In this way members are supplied, each year, with a completely new book with products, names, and addresses all up to date.

According to the editors of the volume, it is the only book which covers the field of mechanical engineering so thoroughly.

A 20-page insert describing all ASME publications is included in this volume for the ready reference of ASME members. This insert describes all books, periodicals, codes, and standards available through the publications sales department.

## ASTM Holds Record Annual Meeting

GROWING interest was noted in materials standardization during the 1951 annual meeting of the American Society for Testing Materials held recently in Atlantic City, N. J. A record registration of over 2000 engineers and technologists took part in 615 technical-committee meetings with the result that 57 new specifications and tests were approved and over 200 existing standards were revised.

ASTM began functioning as a committee in 1898 but was officially incorporated as a national technical society in 1902. Plans are now under way for celebrating the society's 50th anniversary during the 1952 annual meeting scheduled for New York, N. Y., June 23–27, 1952. The celebration will be marked by special events in which leading scientists and engineers from abroad will participate.

T. S. Fuller, engineer in charge, works laboratory, General Electric Company, Schenectady, N. Y., was elected ASTM president for 1951–1952. L. C. Beard, Jr., assistant director, Socony-Vacuum Laboratories, New York, N. Y., was elected vice-president.

# Notes on Coming Meetings

## World Congress on Metals Sponsored by ASM

A REVIEW of metal resources of the noncommunist nations of the world will be one of the principal objectives of the World Metallurgical Congress to be held in Detroit, Mich., Oct. 14–19, 1951. Sponsored by the American Society for Metals, the Congress will be held concurrently with the ASM 33rd National Metals Congress and Exposition.

The Congress is expected to attract some 35,000 American and foreign industrial executives and metal scientists who will assess distribution and potential of the world's metal resources available to the noncommunist world.

### Eight Discussions Scheduled

Among the eight major problems to be discussed are the following: Need for increased means of international exchange of basic research ideas which would not endanger national defense; need for accurate knowledge of metal shortages according to countries, and the means of relieving them; need for uniform terminology and research techniques among metal scientists of the free world; lack of an agency to translate and transcribe data from one nation to another; need for more research on alloy-steel behavior at extreme high and low temperatures, particularly for use in newly developed jet and fission-propelled engines; and the high cost of new alloys and need for less expensive production methods for newly developed metals.

### Multilanguage Metals Newspaper

During the Congress, metalists from 22 countries will meet to determine publication policies for a new multilanguage newspaper in the field of metal science. The newspaper will be sponsored by ASM whose Board of Directors has authorized an expenditure of $50,000 to cover cost of preparatory work. The newspaper will appear in the original language of the contributing writers and abstracts in English will be prepared by a staff to be selected.

In connection with the Congress, groups of study tours have been arranged in which foreign conferees will visit 51 cities in 12 states and the District of Columbia to view some of America's biggest industries and methods.

## Standards

THE role of standards in national defense will be the main topic at the second annual National Standardization Conference to be held at the Waldorf-Astoria, New York, N. Y., Oct. 22–24, in conjunction with the 33rd annual meeting of the American Standards Association. Under the general theme, "Strengthening America Through Standards," the conference will report on progress made and steps to be taken in filling the country's

need for more and broader standards in engineering, safety, consumer goods, and other fields.

Thomas D. Jolly, Pittsburgh, Pa., president, American Standards Association, heads the committee in charge of arrangements for the three-day program.

## London Motor Show

CARS and motor products of about fifty different manufacturers from the United States, Canada, and Europe, as well as Great Britain, are expected to be on view at the 36th International Motor Exhibition to be held at Earls Court, London, England, Oct. 17-27, 1951. The exhibition is organized by the Society of Motor Manufacturers and Traders. Said to be the world's biggest annual motor show, the exhibition will also include special bodies, motor boats and marine engines, trailers, garage equipment, accessories and components, and tires.

Free admission tickets are available to overseas traders, buyers, and distributors by writing to Manager, Society of Motor Manufacturers and Traders, 148 Piccadilly, London, W. 1, England.

## Corrosion

A SYMPOSIUM on corrosion to be sponsored jointly by the Western Region of the National Association of Corrosion Engineers and the Southern California District Council of the American Society for Testing Materials will be held at Rodger Young Auditorium and the Biltmore Hotel, Los Angeles, Calif., Nov. 8-9, 1951. In addition to the presentation of four technical papers, the two-day symposium will feature the 1951 Edward Marburg Lecture, and field trips to a protective-coating manufacturing plant and the LaVerne Water Softening and Treating Plant.

## Chemical Industries

MORE than 380 leading concerns will display new and improved chemical materials and processing equipment on all four exposition floors of Grand Central Palace, New York, N. Y., at the 23rd Exposition of Chemical Industries to be held Nov. 26-Dec. 1, 1951. New processes and plants for high-production, low-cost manufacture of materials now in great demand will be on exhibit.

## AAAS

A TENTATIVE program of seven sessions for Section "M" Engineering has been announced by Frank D. Carvin, secretary, for the 1951 annual meeting of the American Association for the Advancement of Science to be held in Philadelphia, Pa., Dec. 26-31, 1951. Section "M," Mr. Carvin said, is planning to hold during the meeting, joint sessions with the Philadelphia Engineers Club, The American Society of Mechanical Engineers, and The Franklin Institute. Sessions are also planned on nuclear engineering and social physics.

ASME will co-sponsor the morning and afternoon session on Thursday, Dec. 27, to be held in Room 200, Municipal Auditorium.

## Plastics

THE role of plastics in civilian and defense economy will be the theme of the Eighth Annual National Technical Conference of the Society of Plastics Engineers, Inc., to be held in the Edgewater Beach Hotel, Chicago, Ill., Jan. 16-18, 1952.

The SPE, whose president is Islyn Thomas, Thomas Manufacturing Company, Newark, N. J., has more than 2100 members working in the plastics industry. Its objectives are to encourage original work in plastics engineering, promote engineering standards, and enrich the literature of plastics technology.

# People

## T. R. Jones to Receive Gantt Medal

THOMAS R. JONES, president of Daystrom, Incorporated, Elizabeth, N. J., has been awarded the 1951 Henry Laurence Gantt medal for "distinguished achievement in industrial management as a service to the community." Presentation of the award will be made Nov. 28, 1951, during the ASME Annual Meeting.

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MAX JAKOB, Mem. ASME, research professor of mechanical engineering, Illinois Institute of Technology, Chicago, Ill., and DONALD F. OTHMER, Mem. ASME, professor of chemical engineering, head of department, Polytechnic Institute of Brooklyn (N. Y.), were among the 18 prominent scientists appointed as a scientific advisory council to Picatinny Arsenal, Dover, N. J.

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BRIG. GEN. STEWART E. REIMEL (RET), MEM. ASME, WAS RECENTLY NAMED "CHEVALIER" IN THE NATIONAL ORDER OF THE LEGION OF HONOR BY DECREE OF THE PRESIDENT OF THE FRENCH REPUBLIC. HE IS NOW CONSULTANT TO THE DEFENSE PRODUCTION ADMINISTRATION AND IS FORMER CHIEF OF THE NEW YORK ORDNANCE DISTRICT. GENERAL REIMEL IS ALSO SECRETARY OF THE COMMITTEE OF INTERNATIONAL RELATIONS OF THE ENGINEERS JOINT COUNCIL

## ASME Elects Seven to the Grade of Fellow

THE American Society of Mechanical Engineers elected seven members to the grade of Fellow. They are: Jay A. Freiday, mechanical engineer, Ebasco Services Incorporated, New York, N. Y.; George P. Jackson, chief engineer, Combustion Engineering-Superheater, Inc., New York, N. Y.; Albert M. Johnson, chairman of the board, Barnes Drill Company, Rockford, Ill.; G. L. Larson, chairman, department of mechanical engineering, University of Wisconsin; Judson H. Mansfield, chief engineer, Greenlee Bros. & Co., Rockford, Ill.; William B. Shannon, engineering officer of the British Electricity Authority, South Eastern Division, Kingston-upon-Thames, Surrey, England; and Ernest Wildhaber, research and theory engineer, Gleason Works, Rochester, N. Y.

To be qualified as a nominee to the grade of Fellow one must be an engineer who has acknowledged engineering attainment, 25 years of active practice in the profession of engineering or teaching of engineering in a school of accepted standing, and has been a member of the Society for 13 years. Promotion to the grade of Fellow is made only on nomination by five Fellows or members of the Society to the Council to be approved by Council.

### Jay A. Freiday

JAY A. FREIDAY was born in East Orange, N. J., July 31, 1887. He was educated at Mechanics Institute and the Polytechnic Institute of Brooklyn. His early training was as a mechanical designer working on improvements of heating systems and electric-lighting systems for railway cars; and later, on steam engines and pumps, when he moved up to take charge of designing the waterworks plant for the City of Parkersburg, W. Va. From 1911 to 1916, as designer and assistant engineer, New York Edison Company, he was in charge of all mechanical design and engineering for several plants in New York State. Later, during his association with Thomas E. Murray, he carried on, in conjunction with the operating department of the New York Edison Company, experiments in modifying existing equipment and installing untried new equipment, with the purpose of improving power-plant economies. In association with several other members of the ASME, led by H. LeRoy Whitney, then of The M. W. Kellogg Company, he started collecting data to be used in improving

design of piping systems, particularly with elation to high pressures and temperatures.

This group was the nucleus that was later to become the ASA Sectional Committee on Code for Pressure Piping, B31. He worked closely with Mr. Murray in the development of water-cooled furnaces and was responsible for the design of the first "Murray" fin-tube furnace which was installed in the Hell Gate Station (New York Edison Company) and many subsequent installations. His work also resulted in a successful ash-sluicing system and a furnace to burn pulverized coal safely in combination with wood refuse, after this combination had caused several fatal explosions in automobile plants. He holds many patents which cover the work he has accomplished in this field and has written several papers relating to power plants, equipment, and piping which were widely published. More recently his work at Ebasco Services Incorporated has been closely associated with the development of an outdoor-type steam-electric-station installation.

### George P. Jackson

GEORGE P. JACKSON was born in Fentress, Va., Jan. 1, 1888. In 1906 he was graduated from Virginia Polytechnic Institute with a BS degree, and in 1908 received the ME degree from Cornell University. He contributed greatly to the rapid development of pulverized-fuel firing, from its early experimental stages to the present-day successful commercial applications. Furnaces in wide use now, starting with the air-cooled wall type and through the various stages of partial water cooling up to the present fully water-cooled types, were improved by the design factors which he developed and established. Many of his more important designs were a major factor in the development and improvement of large and small steam-generating units, pulverized-coal burners, coal driers, air heaters, traveling-grate stokers, multiple-retort stokers, spreader stokers, rear-arch furnaces, tangential firing, overfire-air and steam-jet applications, and many other advancements that are now accepted as standard practice. He holds over 35 patents and eight that are now pending.

### Albert M. Johnson

ALBERT M. JOHNSON was born in Kishwaukee, Ill., April 9, 1880. He was graduated from the University of Illinois in 1903 with a BSME degree. He is noted for his outstanding contributions in the field of drilling, tapping, and honing machinery, and especially for his work in the development of both vertical and horizontal honing machines. He is a charter member and one of the organizers of the ASME Rock River Valley Section; he was chairman of the Section in 1929 and served on the Executive Committee for many years.

In 1940 he was chairman of the ASME Machine Shop Practice Division. He is the author of a number of papers on the honing process which were published in technical journals.

During the period from 1907 to 1947, over 40 patents covering improvements in drilling, tapping, and honing machines were granted in his name.

### G. L. Larson

G. L. LARSON was born in Werpinge, Lund, Sweden, June 30, 1881. He was graduated from the University of Idaho with a BSEE degree in 1907; received an ME degree from the University of Wisconsin in 1915. From 1907 to 1909 he was employed as a test engineer by the General Electric Company, Schenectady, N. Y., handling various types of electric machinery and steam turbines. He was advanced to head of the induction-motor-testing department. In 1909 he went to the University of Idaho as an assistant professor in charge of mechanical engineering; and in 1911 he was made professor. In 1914 he began his long association with the University of Wisconsin, rising to the office of chairman of the department of mechanical engineering in 1920, a position that he held for 24 years. He was appointed in 1917 as consulting engineer at large by the United States War Department Ordnance Division, and in this capacity had charge of the acceptance test of the hydrogen compressors that were built for and installed in the U. S. Government Nitrate Plant at Muscle Shoals, Tenn. Professor Larson has served on the Wisconsin Industrial Commission to aid in drafting a heating and ventilating code for the State of Wisconsin. He has had vast experience as a consultant in the field of heating, ventilating, air-conditioning, and heat-power engineering. In 1936 he was president of the American Society of Heating and Ventilating Engineers. He has served on the Advisory Committee of the Power Exposition. In 1940 he was chairman of the ASME Rock River Valley Section. He is the author of many bulletins and technical papers.

### Judson H. Mansfield

JUDSON H. MANSFIELD was born in Woodstock, Ill., Nov. 19, 1887. At the age of 18 he was apprenticed as patternmaker to Greenlee Bros. & Company. Except for one year he has been with the company continuously and is now chief engineer. He has had a hand in the development of many products, such as automatic railroad ties, many types of multiple-spindle automatic screw machines, transfer machines for airplane-engine cylinder heads, and hydraulic pipe benders, to name a few on which he holds patents. He has had several papers published in technical and scientific journals. He was a member of the American Standards Association Z14 Sectional Committee on Drawing and Drafting Room Practice to revise Standard Z14.1. In 1930 and 1931 he was chairman of the ASME Rock River Valley Section.

### William Boyd Shannon

WILLIAM B. SHANNON was born in Glasgow, Scotland, June 19, 1896. He received his engineering education as follows: 1914 to 1925, with war-service interruptions, Royal Technical College, senior engineering and special physics; with certification from City and Guilds of London, St. Andrews, and London Universities; and special engineering courses, Royal Ordnance College, Woolwich. From 1942 to 1945 he co-operated in the problem of research and application, at Battersea and Renfrew, of tube joints in alloy-steel drums. The successful resolution of the problem resulted in 100,000 kw of the most efficient plant in Europe being placed in service. The subject was covered for the first time in a paper of which he is co-author, presented before The Institutions of Electrical and Mechanical Engineers in 1945. For this paper he was granted the Hawksley gold medal and premium. He worked on the problems associated with the flash-welding of austenitic steels and on austenitic to ferritic steels.

He was associated with the development work of power-pipe-line butt welds, butt-welding technique, and nondestructive testing; following which he became the representative of The Institution of Mechanical Engineers on the B.S.I. Committee on Pipe-Line Welding.

He produced as combined effort, in association with colleagues of the London Power Company, flange component designs for high pressures and temperatures which were beyond the existing standards at the time. For several years he was involved in an investigation into the analyses and heat-treatments of alloy steels; and he supervised a comprehensive series of impact and other tests on stud bolts and nuts after prolonged performance in power stations. He was closely concerned with various aspects of the pioneer works of Sir Leonard Pearce, particularly on Battersea power station and the initial troubles with early developments in connection with high temperatures, fabrication, and flue-gas washing systems. He is considered by his engineering colleagues to have special knowledge of engineering materials from billet stage to the finished product, and has advised and suggested lines of research for well-known steelmakers' laboratories which have resulted in the production of suitable steels for high-temperature service.

He is the author of several technical papers, discussion contributions, and co-author of a book on the subject.

### Ernest Wildhaber

ERNEST WILDHABER was born in Lucerne, Switzerland, Oct. 22, 1892. When he was graduated from the Federal Polytechnic Institute, Zürich, Switzerland, in 1916, he received an ME degree. He holds 171 patents of which 131 are assigned to the Gleason Works. His achievements include the reducing to practice the production of the hypoid gear, the influence of which is apparent in every passenger automobile produced in the United States, as well as in many trucks, buses, and other mechanical installations. In the "Revacycle," an entirely new process for cutting bevel gears, both the gear and the method of producing it are Mr. Wildhaber's invention. The method makes practical the completion of a tapered profile tooth in a single operation, reducing the production time on bevel gears. He also invented the machine for producing ground teeth on spiral bevels, Zerols, and hypoid gears, as well as the method and machine for producing the curvic coupling. He is the author of several papers in this field.

He has served on the ASME Special Research Committee on the Strength of Gear Teeth.

# Tentative Program for the 1951 ASME Annual Meeting

## *Chalfonte-Haddon Hall, Atlantic City, N. J., Nov. 26–30*

### MONDAY, NOVEMBER 26

**9:30 a.m. Mon.**

**Oil and Gas Power (I)—
Gas Turbine Power (I)**

**Research in Exhaust Manifolds,** by *P. H. Schweitzer*, professor of engineering research, Pennsylvania State College, State College, Pa.

**Summary of Investigation of Two-Stroke-Cycle Gas-Generator Aircraft Engine,** by *Bernard I. Sather, F. Ralph Schuricht*, and *Arnold E. Biermann*, Lewis Flight Propulsion Laboratory, NACA, Cleveland, Ohio.

**9:30 a.m. Mon.**

**Fluid Meters (I)**

***Symposium on Pulsation in Fluid Measurement***

**Basic Difficulties in Pulsating Flowmeters,** by *Allen R. Deschere*, associate professor, department of mechanical engineering, University of Colorado, Boulder, Colo.

**Orifice and Flow Coefficients in Pulsating Flow,** by *Newman A. Hall*, professor of mechanical engineering, Institute of Technology, University of Minnesota, Minneapolis, Minn.

**The Dynamics of Pulsative Flow Through Sharp-Edged Restrictions With Special Reference to Orifice Metering,** by *R. C. Baird*, principal research engineer, and *Ira C. Bechtold*, manager of research and development, The Fluor Corporation, Ltd., Los Angeles, Calif.

**Pulsations in Gas-Compressor Systems,** by *E. G. Chilton* and *L. R. Handley*, research engineers, Shell Development Company, Emeryville, Calif.

**9:30 a.m. Mon.**

**Heat Transfer (I)**

**Some Observations on the Accuracy of the Finite-Difference Method for Transient Heat-Conduction Problems,** by *H. G. Elrod, Jr.*, Harvard University, Cambridge, Mass.

**Heat Transfer From Spheres to a Rarefied Gas in Supersonic Flow,** by *R. M. Drake, Jr.*, assistant professor of mechanical engineering, University of California Berkeley, Calif., and *G. H. Backer*.

**An Experimental Investigation of Convective Heat Transfer to Air From a Flat Plate With a Stepwise Discontinuous Surface Temperature,** by *S. Scesa*, Grass Valley, Calif., and *Fred M. Sauer*, instructor, mechanical engineering department, University of California, Berkeley, Calif.

**9:30 a.m. Mon.**

**Applied Mechanics (I)**

**Bending of a Circular Beam Resting on an Elastic Foundation,** by *Enrico Volterra*, associate professor, Illinois Institute of Technology, Chicago, Ill. Paper No. (51—A-18).

**The Bending of Uniformly Loaded Sectorial Plates With Clamped Edges,** by *H. D. Conway*, associate professor, and *M. K. Huang*, instructor of mechanics, Cornell University, Ithaca, N. Y. Paper No. (51—A-24).

**Linear Bending Theory of Isotropic Sandwich Plates by an Order of Magnitude Analysis,** by *George Gerard*, assistant professor, New York University, New York, N. Y. Paper No. (51—A-31).

**The Bending of a Cylindrically Aeolotropic Circular Plate With Eccentric Load,** by *A. M. Sen Gupta*, department of mathematics, Bengal Engineering College, Sibpur, Howrak, West Bengal, India. (By Title.)* Paper No. (51–A-17).

*Not presented orally; preprint available.

**9:30 a.m. Mon.**

**Education—Management (I)—Junior (I)**

***The Training of Young Engineering Graduates in Industry.***

**From the Standpoint of a Smaller Company,** by *G. W. Baughman*, assistant vice-president, Union Switch and Signal Company, Swissvale, Pa.

**From the Standpoint of a Medium-Sized Company,** by *E. G. Bailey*, The Bailey Meter Company, New York N. Y.

**From the Standpoint of a Larger Company,** by *H. C. Houghton*, assistant to manager of personnel, Bethlehem Steel Company, Bethlehem, Pa.

**9:30 a.m. Mon.**

**Wood Industries (I)**

**Elements of Circular-Saw Design,** by *Norman C. Bye*, Henry Disston and Sons, Inc., Philadelphia, Pa.

**Woodworking-Machinery Manufacturers Look at Carbide-Tool Cutting,** by *Ray C. Dubrucq*, vice-president, Crescent Machine Division, Rockwell Manufacturing Company, Washington, D. C.

**Comparative Costs of Carbide-Tipped Saws,** by *Claud E. Drake*, president, Drake Corporation, St. Louis, Mo.

**9:30 a.m. Mon.**

**Fuels (I)**

**Thermodynamic Charts for Gasification of Coal With Oxygen and Steam,** by *W. C. Edminster, H. Perry, R. Corey*, and *M. A. Elliott*, U. S. Bureau of Mines. Paper No. (51—A-20).

**Flow and Combustion Stability,** by *N. P. Bailey*, professor, mechanical-engineering department, Rensselaer Polytechnic Institute, Troy, N. Y.

**9:30 a.m. Mon.**

**Industrial Instruments and Regulators (I)**

**An Electromagnetic Flowmeter for the Measurement of Oscillating Flows and Its Applications,** by *Eugene Mittlemann*, physicist, consulting engineer, Chicago, Ill.

**Instrumentation and the Medical Scientist,** by *David L. Drabkin*, head, physiological chemistry, Graduate School of Medicine, University of Pennsylvania, Philadelphia, Pa.

**Measurements and Automatic Control of Engine Performance,** by *C. S. Draper and Y. T. Li*, Massachusetts Institute of Technology, Cambridge, Mass.

**12:15 p.m. Mon.**

**President's Luncheon**

Speaker: Retiring President, *J. Calvin Brown*, Mem. ASME.
Subject: **Benjamin Franklin—Statesman, Diplomat, Inventor, Author.**

ALONG THE BOARDWALK AT ATLANTIC CITY, NEW JERSEY

(Atlantic City, where the 1951 ASME Annual Meeting will be held, offers many advantages not available in New York City. Since November is off-season along the boardwalk, members will find that hotel facilities, restaurants, and other public facilities are abundant and reasonable. There will be few intrusions upon the main business of the meeting which is the pleasure of good technical discussions and the pleasure of meeting old friends and making new ones.)

### *Official Notice*
### ASME Business Meeting

THE Annual Business Meeting of the members of The American Society of Mechanical Engineers will be held on Monday afternoon, Nov. 26, 1951, at 5:00 p.m. in the Viking Theater, 13th floor, Haddon Hall Hotel, Atlantic City, N. J., as a part of the Annual Meeting of the Society.

Members are urged to attend.

**2:30 p.m. Mon.**

**Gas Turbine Power (II)—Power (I)**

**The Gas-Turbine's Contribution to Gas-Line Pumping,** by *T. J. Putz,* locomotive and turbine engineering, Westinghouse Electric Corporation, Lester, Pa.

**A 5000-Hp Gas-Turbine Power Plant,** by *Bruce O. Buckland,* engineer, and *Donald C. Berkey,* section engineer, gas turbine engineering division, General Electrical Company, Schenectady, N. Y.

**2:30 p.m. Mon.**

**Fluid Meters (II)**

**Discharge Measurements by Means of Cylindrical Nozzles,** by *Andre L. Jorissen,* head, department of hydraulics and hydraulic engineering, School of Civil Engineering, Cornell University, Ithaca, N. Y., and *Heber T. Newton,* graduate assistant, Pennsylvania State College, State College, Pa.

**Progress Report on the Study of Supercompressibility Factors for Natural Gases,** by *R. H. Zimmerman,* assistant professor of mechanical engineering, and *S. R. Beitler,* professor of hydraulic engineering, Ohio State University, Columbus, Ohio.

**Linear-Resistance Meters for Liquid Flow,** by *R. C. Sowers,* graduate student, and *R. C. Binder,* professor of mechanical engineering, Purdue University, West Lafayette, Ind.

**2:30 p.m. Mon.**

**Heat Transfer (II)**

A general discussion will be held of the following papers, and others, included in the heat Transfer discussion in London, England, September, 1951.

**The Effect of Vapor Velocity on Condensation Inside Tubes,** by *A. P. Colburn,* University of Delaware, Newark, Del., and *F. G. Carpenter.*

**Condensation of Vapors on Vertical Banks of Horizontal Tubes,** by *B. E. Short,* professor, mechanical-engineering department, University of Texas, Austin, Texas, and *H. E. Brown.*

**Temperature Distributions for Air Flowing Turbulently in a Smooth Heated Pipe,** by *R. A. Seban* and *T. T. Shimasaki.*

**Heat-Transfer Problems in High-Speed Flows in Rarefied Gases,** by *R. M. Drake, Jr.,* and *E. D. Kane.*

**2:30 p.m. Mon.**

**Applied Mechanics (II)**

**On the Axisymmetric Problem of the Theory of Elasticity for an Infinite Region Containing Two Spherical Cavities,** by *E. Sternberg,* associate professor of mechanics, and *M. A. Sadowsky,* associate professor of mathematics, Illinois Institute of Technology, Chicago, Ill. Paper No. (51—A-10).

**The Effect of a Rigid Circular Inclusion on the Bending of a Thick Elastic Plate,** by *Richard A. Hirsch,* graduate student, Brown University, Providence, R. I. Paper No. (51—A-12).

**Several Approximate Analyses of the Bending of a Rectangular Cantilever Plate by Uniform Normal Pressure,** by *William A. Nash,* mechanical engineer, structural mechanics laboratory, David Taylor Model Basin, Washington, D. C. Paper No. (51—A-28).

**An Approximate Approach for the Torsion Problem of a Shaft With a Circumferential Notch,** by *H. Okubo,* Institute of High Speed Mechanics, Tohoku University, Sendai, Japan. (By Title.)* Paper No. (51—A-16).

* Not presented orally; preprint available.

**2:30 p.m. Mon.**

**Wood Industries (II)**

**Profitable By-Products From Wood-Manufacturing Waste,** by *Paul H. Graham,* Manchester, N. H.

**Economics of Hardboard Manufacture,** by *Armin Elmendorf,* president, Elmendorf Research, Inc., Chicago, Ill.

**Principles of Chair-Frame Design,** by *Aubrey Dunbar,* general superintendent, Tomlinson of High Point, Inc., High Point, N. C.

**2:30 p.m. Mon.**

**Production Engineering (I)—Metal Cutting (I)**

**Tool Forces and Tool-Chip Adhesion in the Machining of Nodular Cast Iron,** by *K. J. Trigger,* professor, department of mechanical engineering, *L. B. Zylstra,* research assistant, department of mechanical engineering, and *B. T. Chao,* research assistant, department of mechanical engineering University of Illinois, Urbana, Ill. Paper No. (51—A-39).

**A Comparison of Parameters for the Machining of Gray Cast Iron,** by *L. V. Colwell,* professor of production engineering, *H. J. Holmes,* assistant professor of production engineering, and *F. B. Rote,* associate professor of production engineering, University of Michigan, Ann Arbor, Mich. Paper No. (51—A-47).

**2:30 p.m. Mon.**

**Fuels (II)**

**Design and Application of Waste-Heat Boilers,** by *K. J. Ray* and *R. Cubberly,* Foster Wheeler Corporation.

**Burning Fuel in a Fluo Solids Bed,** by *C. J. Wall,* New England Lime Company.

**2:30 p.m. Mon.**

**Hydraulic (I)**

**Complete Characteristic Circle Diagram for Turbomachinery,** by *W. M. Swanson.*

**Intake Structures for Vertical Wet-Pit Pumps,** by *I. A. Winter,* head, hydraulic-machinery division, U. S. Department of the Interior, Bureau of Reclamation, Denver, Colo.

**5:00 p.m. Mon.**

**Business Meeting**

**5:30 p.m. Mon.**

**Welcoming Reception**

**6:30 p.m. Mon.**

**Wood Industries Dinner**

Presiding: *Fred F. Wangaard,* chairman, Wood Industries Division; professor, Yale University School of Forestry, New Haven, Conn.
Speaker: *D. Morton Rose,* president, D. M. Rose & Company, Knoxville, Tenn.
Subject: **Fogbound in the Dark.**

**7:00 p.m. Mon.**

**IIRD Dinner**

**8:00 p.m. Mon.**

**Heat Transfer (III)**

Continuation of discussion of papers included in the heat transfer discussion in London, England, September, 1951.

**Heat-Exchanger Analysis by Electrical Analogy Studies,** by *C. F. Kayan.*

**The Determination of the Temperature of Nonluminous Flames by Radiation in Near Infrared,** by *K. Wohl, L. Bernath, H. N. Powell, A. G. Robinson,* and *F. Welty.*

**Interferometric Studies on the Stability and Transition to Turbulence of a Free-Convection Boundary Layer,** by *E. R. G. Eckert,* scientist, NACA, Cleveland, Ohio, and *E. Soehngen,* Flight Research Laboratory, Wright Field, Dayton, Ohio.

**Heat and Momentum Transfer in Turbulent Flow of Mercury,** by *T. B. Drew* and *S. E. Isakoff.*

**8:00 p.m. Mon.**

**Junior (II)**

**A Current Plan for Young Engineers,** by Martin D. Whitaker, president, Lehigh University, Bethlehem, Pa.

**8:00 p.m. Mon.**

**Applied Mechanics (III)**

**Heat-Exchanger Tube-Sheet Design—II. Fixed Tube Sheets,** by *K. A. Gardner,* assistant chief engineer, Griscom-Russell Company, New York, N. Y. Paper No. (51—A-38).

**Stresses and Deformations of Toroidal Shells of Elliptical Cross Section,** by *R. A. Clark, T. I. Gilroy,* and *E. Reissner,* professor, department of mathematics, Massachusetts Institute of Technology, Cambridge, Mass. Paper No. (51—A-11).

**Torsion of Curved Beams of Rectangular Cross Section,** by *Henry L. Langhaar,* associate professor, theoretical and applied mechanics department, University of Illinois, Urbana, Ill. Paper No. (51—A-14).

**On Symmetrical Strain in Solids of Revolution in Spherical Co-Ordinates,** by *Chih-Bing Ling,* senior research officer, Aeronautical Research Laboratory, Taiwan, China, and *Kuo-Liang Yang,* research officer, Aeronautical Research Laboratory, Taiwan, China. (By Title.)* Paper No. (51—A-1).

* Not presented orally; preprint available.

**8:00 p.m. Mon.**

**Power (II)**

**Comparative Efficiencies of Central-Station Reheat and Nonreheat Turbine-Generator Units,** by *C. W. Elston,* division engineer, steam turbine engineering division, and *P. H. Knowlton,* thermodynamic engineer, turbine engineering divisions, General Electric Company, Schenectady, N. Y.

**Thermal Performance of Modern Turbines,** by *H. R. Reese,* assistant section manager, and *J. R. Carlson,* appliance engineering manager, Westinghouse Electric Corporation, Philadelphia, Pa.

**8:00 p.m. Mon.**

**Production Engineering (II)**

***Education for Production Engineers***

## Registration Schedule

| | |
|---|---|
| Sun., Nov. 25 | 2:00 p.m. to 5:00 p.m. |
| Mon., Nov. 26 | 8:00 a.m. to 8:00 p.m. |
| Tues., Nov. 27 | 8:00 a.m. to 8:00 p.m. |
| Wed., Nov. 28 | 8:00 a.m. to 7:00 p.m. |
| Thurs., Nov. 29 | 8:00 a.m. to 8:00 p.m. |
| Fri., Nov. 30 | 8:00 a.m. to 3:00 p.m. |

## Fees for Nonmembers

A registration fee of $5 will be charged nonmembers attending the 1951 Annual Meeting of The American Society of Mechanical Engineers. The fee for student nonmembers will be $1.

The following nonmembers will be exempt from the payment of the registration fee

- Immediate family of a member (any grade)
- Authors listed in the program or their appointed representatives
- Invited discussers
- Session chairmen and vice-chairmen
- Committeemen required to attend a meeting of their committee
- Session aides
- Members of the ASME Woman's Auxiliary
- Members of The Engineering Institute of Canada
- Members of societies listed in the program
- Distinguished guests invited by the President or Secretary.

## ASME 1951 Annual Meeting—*Program in Brief*—Chalfonte-Haddon Hall Hotel, Atlantic City, N. J.

| | MONDAY—November 26 | TUESDAY—November 27 | WEDNESDAY—November 28 | THURSDAY—November 29 | FRIDAY—November 30 |
|---|---|---|---|---|---|
| 8:00 a.m. | Registration | Registration | Registration | Registration | Registration |
| 9:30 a.m.[1] | Oil & Gas Power (I)—Gas Turbine Power (I)<br>Fluid Meters (I)<br>Heat Transfer (I)<br>Applied Mechanics (I)<br>Education—Management (I)—Junior (I)<br>Wood Industries (I)<br>Fuels (I)<br>IIRD (I) | Oil & Gas Power (III)<br>Gas Turbine Power (III)<br>Production Engineering (III)<br>Heat Transfer (IV)<br>Rubber & Plastics (I)<br>Power (III)<br>Management (II)<br>IIRD (III) | Gas Turbine Power (V)—Fuels (VI)—Applied Mechanics (V)<br>Aviation (I)<br>Materials Handling (I)<br>Production Engineering (VI)—Cutting Fluids<br>Machine Design (I)<br>Heat Transfer (VI)<br>Power (VI)<br>Management (IV)<br>Applied Mechanics (VI) | Aviation (III)—Materials Handling (III)<br>Railroad (II)—Oil & Gas Power (IV)<br>American Rocket Society (II)<br>Machine Design (III)<br>Boiler Feedwater Studies (I)—Power (IX)<br>Metals Engineering (I)—Production Engineering (VII)<br>Petroleum (I)—Effect of Temperature (I)<br>Safety—Management (VI) | American Rocket Society (IV)<br>Textile (I)<br>Hydraulic (V)<br>Fuels (VIII)—Power (XII)<br>Applied Mechanics (X)—Lubrication (III) |
| 12:15 p.m. | President's Luncheon | Heat Transfer Luncheon<br>Production Engineering Luncheon<br>Fuels Luncheon | Honors Luncheon | Members & Students Luncheon | Textile Luncheon<br>2:00 p.m.<br>Program Planning Conference |
| 2:30 p.m. | Gas Turbine Power (II)—Power (I)<br>Fluid Meters (II)<br>Heat Transfer (II)<br>Applied Mechanics (II)<br>Wood Industries (II)<br>Production Engineering (I)—Metal Cutting (I)<br>Fuels (II)<br>Hydraulic (I) | Gas Turbine Power (IV)—Heat Transfer (V)<br>Production Engineering (IV)<br>Rubber & Plastics (II)<br>Power (IV)<br>Management (III)<br>Applied Mechanics (IV)—Plastic Flow of Metals<br>Fuels (IV)<br>Hydraulic (III) | 2:45 p.m.<br>Gas Turbine Power (VI)—Power (VII)<br>Aviation (II)<br>Materials Handling (II)<br>Railroad (I)<br>Machine Design (II)<br>Furnace Performance Factors—Fuels (VII)—Heat Transfer (VII)—Power (VIII)<br>Applied Mechanics (VII)<br>Management (V)<br>American Rocket Society (I) | Railroad (III)—Materials Handling (IV)<br>American Rocket Society (III)<br>Boiler Feedwater Studies (II)—Power (X)<br>Effect of Temperature (II)—Metals Engineering (II)<br>Petroleum (II)<br>Process Industries<br>Lubrication (I)<br>Applied Mechanics (VIII) | American Rocket Society (V)<br>Textile (II) |
| 5:00 p.m.<br>5:30 p.m.<br>6:00 p.m.<br>6:30 p.m. | Business Meeting<br>Welcoming Reception<br><br>Wood Industries Dinner | Roy V. Wright Lecture<br>Tea Dance<br>Applied Mechanics Dinner<br>Hydraulic Old Timers Dinner | | Nuclear Energy<br>American Rocket Society Dinner | |
| 8:00 p.m. | Heat Transfer (III)<br>Junior (II)<br>Applied Mechanics (III)<br>Power (II)<br>Production Engineering (II)<br>Fluid Meters (III)—IIRD (II)<br>Fuels (III)—Oil & Gas Power (II)<br>Hydraulic (II) | Rubber & Plastics (III)<br>Power (V)<br>Vessels Under Pressure<br>Production Engineering (V)—Metal Cutting (II)<br>Fuels (V) | B A N Q U E T | High-Temperature Steam Generation—Power (XI)—Effect of Temperature on Metals (III)<br>Lubrication (II)<br>Hydraulic (IV)<br>Metals Engineering (III)—Applied Mechanics (IX) | |
| 9:30 p.m. | | Monte Carlo Night | | | |
| | MONDAY—November 26 | TUESDAY—November 27 | WEDNESDAY—November 28 | THURSDAY—November 29 | FRIDAY—November 30 |

**Production Project Work for Industrial Engineering Studies,** by *B. W. Saunders*, professor, department of mechanical engineering, Cornell University, Ithaca, N. Y.

**Content of Industrial Engineering Courses,** by *L. C. Lander*, chairman, industrial engineering, General Motors Institute, Flint, Mich.

**Plans and Progress With British Industrial Engineering Education,** by *T. V. Matthew*, University of Birmingham, Birmingham, England.

8:00 p.m. Mon.

### Fluid Meters (III)—IIRD (II)

**Coefficients of Herschel-Type Venturi Tubes,** by *Andre L. Jorissen*, head, department of hydraulics and hydraulics engineering, Cornell University, Ithaca, N. Y.

**Nozzle Characteristics in High-Vacuum Flows,** by *R. G. Folsom*, chairman, division of mechanical engineering, University of California, Berkeley, Calif.

**Electromagnetic Flowmeters,** by *H. G. Elrod, Jr.*, and *R. R. Fouse*, research engineers, Babcock & Wilcox Company, Alliance, Ohio.

8:00 p.m. Mon.

### Fuels (III)—Oil and Gas Power (II)

**Diesel Fuel Performance,** by *R. W. Van Sant*, Gulf Oil Corporation.

**Commercial-Burner Oil Specifications,** by *I. V. Risek*, Cleaver-Brooks Company.

**Fuel Requirements for Aircraft Gas-Turbine Engines,** by *L. C. Gibbon*, Lewis Laboratory, National Advisory Committee for Aeronautics.

8:00 p.m. Mon.

### Hydraulic (II)

**Runaway Speed of Kaplan Turbines,** by *Grant H. Voaden*.

**The Mean Flow in Kaplan Turbines,** by *R. E. Meyer*, University of Maryland, College Park, Md.

## Tuesday, November 27

9:30 a.m. Tues.

### Oil and Gas Power (III)

***Panel Discussion: Effect of the Lubricating Oil Upon Diesel and Gas-Engine Performance***

**Lubrication,** by *John Gibb*, Socony Vacuum Oil Company, New York, N. Y.

**Bearings,** by *E. W. Crankshaw*, Cleveland Graphite Bronze Company, Cleveland, Ohio.

**Engines,** by *George Steven*, Worthington Pump and Machinery Corporation, Buffalo, N. Y.

**Filters,** by *F. Lee Townsend*, manager, William W. Nugent and Company, Chicago, Ill.

**Liners and Pistons,** by *Stuart Nixon*, Sealed Power Corporation, Muskegon, Mich.

9:30 a.m. Tues.

### Gas Turbine Power (III)

**Operating Experience With Stationary Gas Turbine,** by *Paul R. Sidler*, president, Brown Boveri Corporation, New York, N. Y.

**Behavior of Water Particles in Wet-Compression Process of an Axial-Flow Compressor,** by *S. L. Soo*, Harvard University, Cambridge, Mass.

9:30 a.m. Tues.

### Production Engineering (III)

***Production Engineering Clinic***

Moderator: *Ernest, J. Abbott* manager, PRCo Products, Ann Arbor, Mich.

**Panel:** Members to be announced.

Topics: 1 Purchase Engineering; 2 Production Facilities—Equipment and Tooling; 3 Production Processes—Machining, welding, casting, stamping, assembly, etc.; 4 Inspection—Receiving, intermediate, final. (Note: The morning and afternoon sessions will be operated as a unit, with a luncheon between.)

9:30 a.m. Tues.

### Heat Transfer (IV)

**Heat Transfer by Gas Conduction and Radiation in Fibrous Insulation,** by *Jack D. Verschoor*, physicist, Johns Manville Research Center, Manville, N. J., and *P. Greebler*

**A Method of Correlating Heat-Transfer Data for Surface Boiling of Liquids,** by *W. M. Rohsenow*, mechanical-engineering department, professor, Massachusetts Institute of Technology, Cambridge, Mass.

**Heat Transfer and Pressure Drop for Turbulent Flow of Air-Water Mixture in a Horizontal Pipe,** by *Harold A. Johnson*, mechanical-engineering department, and *A. H. Abou-Sabe*, University of California, Berkeley, Calif.

9:30 a.m. Tues.

### Rubber and Plastics (I)

**Effect of Velocity on the Tensile Impact Properties of Polymethyl Methacrylate,** by *Bryce Maxwell* and *J. P. Harrington*, plastics laboratory, Princeton University, Princeton, N. J.

**On the Accuracy of Extrapolated Creep-Test Relations for Plexiglas Subjected to Various Stresses,** by *Joseph Marin* and *Yoh-Han Pao*, department of engineering mechanics, Pennsylvania State College, State College, Pa.

**High Impact Styrenes—A New Class of Thermoplastic Materials,** by *Sanford E. Glick* and *C. H. Adams*, plastics division, Monsanto Chemical Company, Springfield, Mass.

9:30 a.m. Tues.

### Power (III)

**Modern Reheat Turbines—Recent Experience and Design Progress,** by *C. Schabtach*, divisions engineer, steam turbine and generator engineering divisions, and *R. Sheppard*, assistant division engineer, steam turbine engineering division, General Electric Company, Schenectady, N. Y.

**Present Development of the Reheat Steam Turbine,** by *R. L. Reynolds*, manager, central station turbine section, Westinghouse Electric Corporation, Philadelphia, Pa.

9:30 a.m. Tues.

### Management (II)

***Strength Through Productivity***

**This Thing Called Productivity,** by *Ewan Clague*, United States Commissioner of Labor Statistics, Bureau of Labor Statistics, Washington, D. C.

**How Much Production Do We Need?** Speaker to be announced.

9:30 a.m. Tues.

### Industrial Instruments and Regulators (III)

**Analysis of Some Hydraulic Components Used in Regulators and Servomechanisms** by *S. L. Cahn* and *S. Z. Dushkes*, development department, special devices division, Askania Regulator Company, Chicago, Ill. Paper No. (51—A-22).

**Instrument Accuracy With Proportioning Pumps,** by *J. Nelson Swarr*, control engineer, chemistry division, Corn Products Refining Company, Argo, Ill.

**System Synthesis Through Block-Diagram Analysis,** by *John M. Embree* and *Stephen P. Higgins, Jr.*, research and development engineers, Minneapolis-Honeywell Regulator Company, Brown Instruments Division, Philadelphia, Pa.

### Woman's Auxiliary

An excellent program has been arranged for women visitors by the ASME Woman's Auxiliary. The program will include two luncheons and a banquet. On Monday, the program will feature a lecture and motion picture in the afternoon and a bridge party at night. The next day there will be the Auxiliary president's breakfast, a tea dance, and a Monte Carlo party, and on Wednesday, in addition to the Annual Banquet, the Annual Business Meeting of the Woman's Auxiliary will be held.

12:15 p.m. Tues.

### Heat Transfer Luncheon

Presiding: *G. L. Tuve*, chairman, ASME Heat Transfer Division, professor, Case Institute of Technology, Cleveland, Ohio.

Speaker: *E. R. G. Eckert*, NACA Lewis Flight Propulsion Laboratory, Cleveland, Ohio.

Subject: **Problems and Progress in Aircraft Heat Transfer.**

12:15 p.m. Tues.

### Production Engineering Luncheon

Presiding: *R. H. McCarthy*, chairman, ASME Production Engineering Division, superintendent of manufacturing engineering, Western Electric Company, Inc., Kearny, N. J.

Speaker: To be announced.

Subject: **The Development of a Manufacturing Engineering Organization**

12:15 p.m. Tues.

### Fuels Luncheon

Presiding: *C. E. Miller*, chairman, ASME Fuels Division, assistant manager, industrial division, Combustion Engineering-Superheater, Inc., New York, N. Y.

Speaker: To be announced.

2:30 p.m. Tues.

### Gas Turbine Power (IV)—Heat Transfer (V)

**Design and Performance of an Extended-Surface Regenerator,** by *Sven Holm*, research engineer, and *Ray L. Lyerly*, The Air Preheater Corp., Wellsville, N. Y.

**Heat-Transfer and Flow-Friction Characteristics of Some Compact Heat-Exchanger Surfaces, Part 3—Design Data for Five Surfaces,** by *A. L. London*, mechanical-engineering department, and *William M. Kays*, instructor of mechanical engineering, and *D. W. Johnson*, Stanford University, Stanford, Calif.

**Heat-Transfer and Flow-Friction Behavior in Small Cylindrical Tubes—Circular and Rectangular Cross Sections,** by *William M. Kays*, instructor of mechanical engineering, and *A. L. London*, mechanical-engineering department, Stanford University, Stanford, Calif.

**Review of Optimum Design of Regenerators,** by *David Aronson*, head engineer, heat-process section, Elliott Company, Jeannette, Pa.

2:30 p.m. Tues.

### Production Engineering (IV)

***Production Engineering Clinic (Continued from morning session)***

5 Quality Engineering and Control; 6 Production Specifications—drawings, process sheets, routings, material handling, location, etc.; 7 Wage Setting—time standards, rates, etc.; 8 Review Boards, Salvage Committees, etc.; 9 Process Development.

2:30 p.m. Tues.

### Rubber and Plastics (II)

**High-Strength Rubber-Plastic Adhesives,** by *Arman Kearfott*, research laboratories division, General Motors Corporation, Detroit, Mich.

**Rubber-Plastic Compositions,** by *E. S. Ebers*, sales manager, Kralastic and Vibrin Resins, Naugatuck Chemical, Naugatuck, Conn.

**Selected Plastics Literature References for the Mechanical Engineer—July, 1950, Through June, 1951, and (a Motion Picture)—Inside the Injection Machine Mold,** by *Gordon B. Thayer*, plastics technical service, The Dow Chemical Company, Midland, Mich.

2:30 p.m. Tues.

### Power (IV)

**Operation and Performance of Modern Reheat Boilers,** by *P. R. Loughin*, chief staff engineer, and *H. H. Poor*, staff engineer, The Babcock & Wilcox Company, New York, N. Y.

**Some Design Factors Relating to Performance and Operation of Reheat Boilers,** by *H. H. Hemenway*, chief engineer, steam division, Foster Wheeler Corporation., New York, N. Y.

**A Progress Report of Reheat Boiler Operation and Design,** by *W. J. Vogel*, chief engineer, and *E. M. Powell*, design engineer, Combustion Engineering-Superheater, Inc., New York, N. Y.

**2:30 p.m. Tues.**

### Management (III)

***Productivity Through Facilities***

**New Production Facilities,** by *Ralph J. Kraut,* president, Giddings and Lewis Machine Tool Company, Fond Du Lac, Wis.

**How to Increase Productivity in Small Plants,** by *Frank K. Shallenberger,* associate professor of industrial management, Graduate School of Business, Stanford, Calif.

**2:30 p.m. Tues.**

### Applied Mechanics (IV)—Plastic Flow of Metals

**The Safety Factor of an Elastic-Plastic Body in Plane Strain,** by *Daniel C. Drucker,* professor of engineering, Brown University, Providence, R. I., *H. J. Greenberg,* assistant professor of mathematics, Carnegie Institute of Technology, Pittsburgh, Pa., and *W. Prager,* professor of applied mechanics, Brown University, Providence, R. I., Paper No. (51—A-3).

**Partially Plastic Thick-Walled Cylinder Theory,** by *M. C. Steele,* research assistance professor, department of theoretical and applied mechanics, University of Illinois, Urbana, Ill. Paper No. (51—A-25).

**The Theory of Plasticity Applied to a Problem of Machining,** by *E. H. Lee,* associate professor, Graduate Division of Applied Mechanics, Brown University, Providence, R. I., and *Bernard W. Shaffer,* assistant professor of mechanical engineering, New York University, New York, N. Y. Paper No. (51—A-5).

**2:30 p.m. Tues.**

### Fuels (IV)

***Panel: Spreader-Stoker Design for Light Load Operation***

Speakers: *F. C. Messaros,* American Engineering Company; *M. O. Funk,* Combustion Engineering-Superheater, Inc., New York, N. Y.; *H. Wagner,* Detroit Stoker Company; *E. C. Miller,* Riley Stoker Corporation; and *D. J. Mosshart,* Westinghouse Electric Corporation.

**An Investigation of Gravity Reinjection of Fly Ash to a Spreader-Stoker-Fired Boiler Furnace,** by *C. H. Morrow,* J. I. Case Company, *W. C. Holton,* Battelle Memorial Institute, and *H. Wagner,* Detroit Stoker Company.

**2:30 p.m. Tues.**

### Hydraulic (III)

**Measurement of Vibration in a Large Slow-Speed Hydraulic Turbine,** by *John Parmakian* and *R. S. Jacobson*

**High Lights of Recent Developments in Francis Turbines,** by *W. J. Rheingans*

**4:30 p.m. Tues.**

### Tea Dance

**5:00 p.m. Tues.**

### Roy V. Wright Lecture

Presiding: Incoming President, R. J. S. Pigott, Fellow, ASME
Lecturer: W. C. Mullendore, president, Southern California Edison Co., Los Angeles, Calif.
Subject: To be announced.

**6:00 p.m. Tues.**

### Applied Mechanics Dinner

Presiding: *L. H. Donnell,* chairman, ASME Applied Mechanics Division research professor, department of mechanics, Illinois Institute of Technology, Chicago, Ill.
Speaker: *E. U. Condon,* director of research, Corning Glass Company, Corning, N. Y.

**6:00 p.m. Tues.**

### Hydraulic Old Timers Dinner

**8:00 p.m. Tues.**

### Rubber and Plastics (III)

**A New Rotary Seal for High-Speed and High-Pressure Applications,** by *T. J. McCuistion.*

**Properties and Applications of Silicone Rubbers,** by *C. W. Pfeiffer,* General Electric Company, Waterford, N. Y.

**Selected Rubber Literature References for the Mechanical Engineer, July, 1950, Through June, 1951,** by *R. E. Shrader, and R. M. Turner,* Test engineers, E. I. du Pont de Nemours & Co., Wilmington, Del.

L. R. GATY, CHAIRMAN, ARRANGEMENTS COMMITTEE, FOR THE 1951 ASME ANNUAL MEETING

**8:00 p.m. Tues.**

### Power (V)

**Reheat Experience at Port Washington,** by *M. K. Drewry,* assistant chief engineer of power plants, Wisconsin Electric Power Company, Milwaukee, Wis. Paper No. (51—A-45).

**The First Year's Experience of the Dunkirk Steam Station,** by *J. N. Ewart,* chief mechanical engineer, Buffalo Mohawk Power Corporation, Buffalo, N. Y.

**Twenty-Five Years of Reheat Operating Experience on the American Gas and Electric System,** by *S. N. Fiala,* mechanical engineer, head, mechanical-engineering division, American Gas and Electric Service Corp., New York, N. Y.

**Operating Experience With Reheat at Edgar Station,** by *H. E. Stickle,* assistant chief engineer of steam stations. Boston Edison Company, Boston, Mass.

**8:00 p.m. Tues.**

### *Vessels Under External Pressure*

**The New Type Code Chart for the Design of Vessels Under External Pressure,** by *Elmer O. Bergman,* staff consultant, C. F. Braun and Co., Alhambra, Calif.

**A Procedure for Determining the Allowable Out-of-Roundness for Vessels Under External Pressure,** by *Marshall Holt,* assistant chief, engineering design division, Aluminum Research Laboratories, New Kensington, Pa.

**Lateral Buckling of Circular Stiffening Rings in Compression,** by *L. A. Wilkin,* manager, research and development department, and *E. Wetterstrom,* analytical engineer, research and development department, Graver Tank and Manufacturing Company, East Chicago, Ind.

**8:00 p.m. Tues.**

### Production Engineering (V)—Metal Cutting (II)

**Thermophysical Aspects of Metal Cutting,** by *B. T. Chao,* research assistant, *K. J. Trigger,* professor, and *L. B. Zylstra,* research assistant, department of mechanical engineering, University of Illinois, Urbana, Ill. Paper No. (51—A-41).

**The Mechanics of Three-Dimensional Cutting Operations,** by *M. C. Shaw,* associate professor of mechanical engineering, *N. H. Cook,* instructor in mechanical engineering, and *P. A. Smith,* associate professor of mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass.

**The Rotary Cutting Tool,** by *M. C. Shaw,* associate professor of mechanical engineering, *P. A. Smith,* associate professor of mechanical engineering, and *N. H. Cook,* Massachusetts Institute of Technology, Cambridge, Mass.

**A Visual Study of Cutting (15-Minute Motion Picture)** by *N. H. Cook,* instructor in mechanical engineering, and *M. C. Shaw,* associate professor of mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass.

**8:00 p.m. Tues.**

### Fuels (V)

**Impact of Defense Activities on Petroleum Fuel Supplies,** by *Adam K. Stricker,* General Motors Corporation.

**9:30 p.m. Tues.**

### Monte Carlo Party

## Wednesday, November 28

**9:30 a.m. Wed.**

### Gas Turbine Power (V)—Fuels (VI)—Applied Mechanics (V)

**Measurement of High Temperatures in Gas Streams,** by *E. R. Letsch* and *W. Julian King,* University of California, Los Angeles, Calif.

**Effect of High-Frequency Sound Waves on an Air-Propane Flame,** by *C. J., Kippenhan,* Washington University, St. Louis, Mo., and Huber, O. Croft, University of Missouri, Columbia, Mo.

**Photographic Analysis of Sprays,** by *H. E. Stubbs* and *J. Louis York,* University of Michigan, Ann Arbor, Mich.

**9:30 a.m. Wed.**

### Aviation (I)

**Operating Characteristics of Cylindrical Roller Bearings at High Speeds,** by *E. F. Macks, Z. N. Nemith,* and *W. J. Anderson,* Aeronautical Research scientists, NACA, Lewis Flight Propulsion Laboratory, Cleveland Airport, Cleveland, Ohio.

**Some Lubrication and Bearing Problems in Aircraft Gas Turbines,** by *E. M. Phillips,* staff engineer, aviation division, General Electric Company, Lockland, Ohio.

**Some Performance Characteristics of Ball and Roller Bearings for Aircraft Gas Turbines,** by *John Boyd,* manager, lubrication section, and *P. R. Eklund,* research engineer, Westinghouse Research Laboratories, East Pittsburgh, Pa.

**9:30 a.m. Wed.**

### Materials Handling (I)

**Belt Conveyors—Industry's Bulk-Handling Giant,** by *L. O. Millard,* assistant general sales manager, Link Belt Company, Chicago, Ill.

**Development of Conveyer Belting as a Major Transporation Factor,** by *M. W. Sledge,* manager, belting sales, Goodyear Tire and Rubber Company, Akron, Ohio. (A motion Picture.)

**9:30 a.m. Wed.**

### Production Engineering (VI)—Cutting Fluids

**Measuring the Cooling Properties of Cutting Fluids,** by *George M. Hain,* research chemist, The Cincinnati Milling Machine Company, Cincinnati, Ohio. Paper No. (51—A-40).

**A Laboratory Method of Testing Cutting Fluids That Approximates Actual Shop Usage,** by *Thomas Badger,* materials-engineering department, Westinghouse Electric Corporation, East Pittsburgh, Pa.

**9:30 a.m. Wed**

### Machine Design (I)

**Contributions to Hydraulic Control—I. Steady-State Axial Forces on Control-Valve Pistons,** by *Shih-Ying Lee* and *John F. Blackburn,* research engineers, Dynamic Analysis and Control Laboratory, Massachusetts Institute of Technology, Cambridge, Mass.

**Contributions of Hydraulic Control—II. Transient Flow Forces and Valve Instability,** by *Shih-Ying Lee* and *John F. Blackburn.*

**Contributions to Hydraulic Control—III.** by *Shih-Ying Lee* and *John F. Blackburn.*

**9:30 a.m. Wed.**

### Heat Transfer (VI)

**Heat Transfer and Fluid Friction During Flow Across Banks of Tubes,** by *O. P. Bergelin, G. A. Brown,* and *S. C. Doberstein,* University of Delaware, Newark, Del.

**Optimum Cross-Flow Heat Exchanger,** by *J. T. Fong,* mechanical engineer, Burns & Roe, Inc., New York, N. Y.

**The Design of Heat Exchangers for Minimum Irreversibility,** by *F. A. McClintock,* assistant professor of mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass.

9:30 a.m. Wed.

### Power (VI)

**The Development and Implementation of a Generation Program on the American Gas and Electric Company System—I. System Fundamentals,** by *Philip Sporn,* president, American Gas and Electric Service Corporation, New York, N. Y.

**The Development and Implementation of a Generation Program on the American Gas and Electric Company System—II. Fuel Supply,** by *Philip Sporn,* president, and *H. A. Kammer,* vice-president, American Gas and Electric Service Corporation, New York, N. Y.

**The Development and Implementation of a Generation Program on the American Gas and Electric Company System—III. 200,000 Kw, 2000 Psi, 1050 F—An Advance in the Economics of Integrated Power System Generation,** by *Philip Sporn,* president, and *S. N. Fiala,* head, mechanical engineering, American Gas and Electric Corporation, New York, N. Y.

9:30 a.m. Wed.

### Management (IV)

**Productivity Through Manpower Incentives for Better Production Effectiveness,** by *Phil Carroll,* consulting industrial engineer, Maplewood, N. J. Paper No. (51—A-21).

**Changing Philosophies on Wage Incentives,** by *H. B. Maynard,* president, Methods Engineering Council, Pittsburgh, Pa.

9:30 a.m. Wed.

### Applied Mechanics (VI)

**Supersonic Flow With Variable Specific Heat,** by *Franklin P. Durham,* assistant professor of aeronautical engineering, University of Colorado, Boulder, Colo. Paper No. (51—A-13).

**A New Method of Calculation of Reheat Factors for Turbines and Compressors,** by *Joseph Kaye,* associate professor of mechanical engineering, and *Kenneth R. Wadleigh,* assistant professor of mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass. Paper No. (51—A-2).

**A Contribution to the Theory of the Development and Stability of Detonation in Gases,** by *A. K. Oppenheim,* assistant professor of mechanical engineering, University of California, Berkeley, Calif. Paper No. (51—A-23).

12:15 p.m. Wed.

### Honors Luncheon

Presiding: Incoming President *R. J. S. Pigott,* Fellow ASME.

Conferring of honors:

*Hoover Medal:* William L. Batt, head, Economic Cooperation Administration for Great Britain, London, England

*Gantt Medal:* Thomas Roy Jones, president, Daystrom, Inc., Elizabeth, N. J.

*Fritz Medal:* E. G. Bailey, vice-president, Babcock & Wilcox Company, New York, N. Y., and chairman, Bailey Meter Company, Cleveland, Ohio.

2:45 p.m. Wed.

### Gas Turbine Power (VI)—Power (VII)

**Design Features of a 250-Kw Gas-Turbine Engine for Driving Shipboard Emergency Generator,** by *R. R. Peterson,* gas-turbine engineer, Navy Department, Bureau of Ships, Washington, D. C., and *Paul G. Carlson,* Solar Aircraft Company, San Diego, Calif.

**Self-Induced Vibrations in Axial Compressor Blading** (A motion picture), by *P. R. Sidler,* president, Brown Boveri Corporation, New York, N. Y.

2:45 p.m. Wed.

### Aviation (II)

**Characteristics of Vaporizing Combusters for Aviation Gas Turbines,** by *E. P. Walsh,* section engineer, *James R. Hamm,* design engineer, and *W. L. Christensen,* design engineer, Aviation Gas Turbine Division, Westinghouse Electric Corporation, Philadelphia, Pa.

**The Life of High-Speed Ball Bearings,** by *A. B. Jones,* research engineer, The Fafnir Bearing Company, New Britain, Conn.

2:45 p.m. Wed.

### Materials Handling (II)

**Scientific Materials Handling and Installations in the Automotive Industry,** by *L. J. Bishop,* vice-president, Mechanical Handling Sessions, Inc., Detroit, Mich.

**Look to Plant Layout for Efficient Material Handling,** by *R. W. Mallick,* staff engineer, Westinghouse Electric Corporation, East Pittsburgh, Pa.

2:45 p.m. Wed.

### Railroad (I)

**Economic and Efficient Lubrication of Waste Packed Journals,** by *L. D. Grisbaum,* chief engineer, Railway Service and Supply Company, Indianapolis, Ind.

**Economic Study of Roller Bearings on Freight Cars,** by *O. J. Horger,* chief engineer, Railway Division, Timken Roller Bearing Company, Canton, Ohio.

2:45 p.m. Wed.

### Machine Design (II)

**The Magnetic-Particle Clutch,** by *Philip H. Trickey,* chief engineer, Vickers Electric Division, Vickers Inc., St. Louis, Mo.

**Design of Flat-Wound Tension Springs,** by *R. M. Conklin,* supervisor, mechanical-engineering division, and *Donald R. Ferry,* research engineer, Battelle Memorial Institute, Columbus, Ohio.

2:45 p.m. Wed.

### Furnace Performance Factors—Power (VIII)—Fuels (VII)—Heat Transfer (VII)

**An Investigation of the Variation in Heat Absorption in a Natural-Gas-Fired Water-Cooled Steam-Boiler Furnace,** by *Albert R. Mumford,* development engineer, research dept., Combustion Engineering-Superheater, Inc., New York, N. Y., and *Richard C. Corey,* supervision engineer, combustion research section, U. S. Bureau of Mines, Pittsburgh, Pa.

2:45 p.m. Wed.

### Applied Mechanics (VII)

**An Alternative Formulation of the Laws of Mechanics,** by *H. M. Trent,* head applied mathematics branch, Mechanics Division, Naval Research Laboratory, Washington, D. C. Paper No. (51—A-26).

**A Variational Principle for the Mesh-Type Analysis of a Mechanical System,** by *R. A. Toupin,* applied-mechanics branch, mechanics division, Naval Research Laboratory, Washington, D. C.

**On the Direction of Fatigue Cracks in Polycrystalline Ingot Iron,** by *Frank A. McClintock,* assistant professor of mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass. Paper No. (51—A-9).

**A Statistical Distribution Function of Wide Applicability,** by *Waloddi Weibull,* professor, Royal Institute of Technology, Stockholm, Sweden. (By Title.)* Paper No. (51—A-6).

* Not presented orally; preprint available.

## Your Professional Division

SEVEN ASME Professional Divisions have scheduled luncheons or dinners during the 1951 ASME Annual Meeting. They are:

- Applied Mechanics
- Fuels
- Heat Transfer
- Hydraulic
- Production Engineering
- Textile
- Wood Industries

Don't miss these opportunities to meet officers of your Professional Division and members working in your own field. Check program for dates.

2:45 p.m. Wed.

### Management (V)

***Productivity Through Control***

**Productivity Through Stabilized Operation,** by *E. H. MacNiece,* director of quality control, Johnson & Johnson, New Brunswick, N. J.

**Moral and Spiritual Concepts in Production,** by *Erwin H. Schell,* professor of business management, Massachusetts Institute of Technology, Cambridge, Mass.

2:45 p.m. Wed.

### American Rocket Society (I)

**Attitude Stabilization for Supersonic Vehicles,** by *C. W. Besserer,* supervisor of engineering, and *A. J. Bell,* staff engineer, Applied Physics Laboratory, The Johns Hopkins University, Silver Spring, Md.

**Launching Techniques for Rocket Testing,** by *A. W. Nelson* and *H. T. Lotee,* Naval Ordnance Test Station, Inyokern, Calif.

**High-Thrust Liquid-Propellant-Booster Rocket Development,** by *R. J. Thompson,* chief of research, The M. W. Kellogg Company, Jersey City, N. J.

**Unusual Applications of the Momentum Principle,** by *T. F. Reinhardt,* U. S. Naval Air Rocket Test Station, Lake Denmark, Dover, N. J.

6:45 p.m. Wed.

### Banquet

## Thursday, November 29

9:30 a.m. Thurs.

### Aviation (III)—Materials Handling (III)

**Package Appliances to Cargo Handling,** by *J. Allison,* president, Transport Vans, Palo Alto, Calif.

**Air Freight Handling Technique at Kelly Air Force Base, Texas,** by *Lt. Col. I. E. Campbell,* USAF, San Antonio Air Materiel Area, Kelly Air Force Base, San Antonio, Texas.

9:30 a.m. Thurs.

### Railroad (II)—Oil and Gas Power (IV)

**Operating Experience of the Talgo Train,** by *Jerry M. Gruitch,* director, research and development, American Car and Foundry Co., New York, N. Y.

**Development of the General Motors Two-Cycle Railway Diesel Engine,** by *E. W. Kettering,* chief engineer, electromotive division, General Motors Corporation, LaGrange, Ill.

9:30 a.m. Thurs.

### American Rocket Society (II)

**Installation of Rocket Engines in Airplanes,** by *F. A. Coss,* Reaction Motors, Inc., Lake Denmark, Dover, N. J.

**Description of the NOTS Aeroballistics Laboratory,** by *Dr. I. E. Highberg,* Naval Ordnance Test Station, Inyokern, Calif.

**Air Force Experimental Rocket Engine Test Station,** by *Richard A. Schmidt,* 1st Lt., USAF, and *Donald L. Dynes,* test engineer, rocket branch, Edwards Air Force Base, Muroc, Calif.

9:30 a.m. Thurs.

### Machine Design (III)

**Bolt Elongations and Loads,** by *Leonardt F. Kreisle,* assistant professor, mechanical engineering, and *Joseph B. Oliphint,* research engineer, military physics research laboratory, University of Texas, Austin, Texas.

**Hysteresis of Shaft Materials in Torsion,** by *W. P. Welch,* section manager, transportation engineering division, Westinghouse Electric Corporation, East Pittsburgh, Pa., and *B. Cametti.*

9:30 a.m. Thurs.

### Boiler Feedwater Studies (I)—Power (IX)

**The Spectrophotometric Determination of Small Amounts of Soluble Silica in Water,** by *H. E. Robison, E. A. Pirsh,* and *E. Grimm,* Armour Research Foundation, Chicago, Ill.

**Adaptation of the Spectrophotometric Determination of Small Amounts of Soluble Silica in Water to the Determination of Undissolved Forms of Silica,** by *H. E. Robison* and *E. Grimm,* Armour Research Foundation, Chicago, Ill.

**Correlation of Silica Carry-Over and Solubility Studies,** by *Clarence Jacklin* and *S. Robert Brower,* National Aluminate Corporation, Chicago, Ill.

9:30 a.m. Thurs.

### Metals Engineering (I)—Production Engineering (VII)

**Design of Gray-Iron Castings,** by *T. E. Eagan,* chief metallurgist, Cooper-Bessemer Corporation, Grove City, Pa.

**Physical and Mechanical Properties of Cast Iron,** by *W. L. Collins,* professor of theoretical and applied mechanics, University of Illinois, Urbana, Ill.

9:30 a.m. Thurs.

### Petroleum (I)—Effect of Temperature on Metals (I)

**Graphitization in Catalytic-Cracking Unit Reactors,** by *D. B. Rossheim, J. J. Murphy, W. B. Hoyt,* and *H. S. Blumberg,* The M. W. Kellogg Company, New York, N. Y. Paper No. (51—A-26).

**Embrittlement of 12 Per Cent Chromium Steels After Exposure to 750 F and 900 F,** by *M. A. Scheil,* director of metallurgical research, A. O. Smith Corporation, Milwaukee, Wis.

9:30 a.m. Thurs.

### Safety—Management (VI)

**Industry's Last Chance,** by *C. W. Ainsworth,* technical director, American Standards Association, New York, N. Y.

**A Working Program for the Elimination of Industrial Eye Accidents,** by *Robert S. Krueger,* director, industrial service, National Society for the Prevention of Blindness, New York, N. Y.

**The Development of a Procedure and Materials for Integrating Safety Into Mechanical-Engineering Course Content,** by *H. W. Heinrich,* assistant superintendent, engineering and loss control division, The Travelers Insurance Company, Hartford, Conn.

**Some Thoughts on the Relationship of Fatigue to Industrial Losses,** by *John V. Grimaldi,* director, industrial division, Association of Casualty and Surety Companys, New York, N. Y.

12:15 p.m. Thurs.

### Members and Students Luncheon

2:30 p.m. Thurs.

### Railroad (III)—Materials Handling (IV)

**Progress in Railway Mechanical Engineering (Report of Committee RR-6 Survey),** by *T. F. Perkinson,* committee chairman, manager, commercial engineering division, transportation division, General Electric Co., Schenectady, N. Y.

**Symposium—Railroads and Highway Trailers—An Economic Solution to a Difficult Problem,** by *George L. Goebel,* mechanical engineer, New York, New Haven and Hartford Railroad Co., New Haven, Conn., *H. R. Sampson,* vice-president, Chicago and Eastern Illinois Railroad, Chicago, Ill., and *E. F. Ryan,* president, Rail-Trailer, Evanston, Ill.

2:30 p.m. Thurs.

### American Rocket Society (III)

**Isothermic Combustion Under Flow Conditions,** by *J. A. Bierlein* and *K. Scheller,* power plant research engineers, Wright Air Development Center, Wright-Patterson Air Force Base, Dayton, Ohio.

**Film Cooling,** by *Luigi Crocco,* Robert H. Goddard professor, The Daniel and Florence Guggenheim Jet Propulsion Center, Princeton University, Princeton, N. J.

**High-Flux Heat Transfer and Coke Deposition of JP-3,** by *J. B. Hatcher,* Jet Propulsion Laboratory, California Institute of Technology, Pasadena, Calif.

**The Principle of the Concentric Nozzle,** by *W. F. Kaufman* and *B. N. Abramson,* U. S. Naval Air Rocket Test Station, Lake Denmark, Dover, N. J.

2:30 p.m. Thurs.

### Boiler Feedwater Studies (II)—Power (X)

**The Influence of Boiler Design and Operating Conditions on Steam Contamination,** by *Paul M. Brister,* staff engineer, *S. C. Raynor,* and *E. A. Pirsh,* The Babcock & Wilcox Company, New York, N. Y.

**Field Testing of Evaporator Vapor Sampling Nozzles,** by *E. B. Morris,* American Gas and Electric Service Corporation, New York, N. Y.

2:30 p.m. Thurs.

### Effect of Temperature (II)—Metals Engineering (II)

**Effect of Temperature Variations on the Long-Time Rupture Strength of Steels,** by *Ernest L. Robinson,* structural engineer, turbine engineering division, General Electric Company, Schenectady, N. Y. Paper No. (51—A-33).

**A Time-Temperature Relationship for Rupture and Creep Stresses,** by *F. R. Larson,* Watertown Arsenal, Watertown, Mass., and *J. Miller,* General Electric Company, West Lynn, Mass. Paper No. (51—A-36).

**High-Temperature Stress Rupture Testing of Tubular Specimens,** by *L. F. Kooistra,* superintendent, materials division, *R. U. Blaser,* assistant superintendent, materials division, and *J. T. Tucker,* supervisor, stress-analysis group, research and development department, The Babcock & Wilcox Company, Alliance, Ohio. Paper No. (51—A-44).

**Rupture and Creep Characteristics of Titanium-Stabilized Stainless Steel at 1100 to 1300 F,** by *J. W. Freeman,* research engineer, Engineering Research Institute, University of Michigan, Ann Arbor, Mich., *George F. Comstock,* assistant director of research, titanium-alloy manufacturing division, National Lead Company, and *A. E. White,* director, Engineering, Research Institute, University of Michigan, Ann Arbor, Mich. Paper No. (51—A-46).

2:30 p.m. Thurs.

### Petroleum (II)

**Design and Development of High-Pressure Injection Pumps for Hydrogenation Service,** by *J. T. Donovan, B. H. Leonard,* and *J. A. Markovits,* Synthetic Fuels Demonstration Plant, Bureau of Mines, Louisiana, Mo.

**The Stresses in a Pressure Vessel With a Flat Head Closure,** by *G. W. Watts* and *H. A. Lang,* Standard Oil Company of Indiana, Chicago, Ill.

2:30 p.m. Thurs.

### Process Industries

**Air Pollution and the Mechanical Engineer,** by *Frederick G. Sawyer,* administrator, air and water research, Stanford Research Institute, Stanford, Calif.

**Design Factors for Industrial Heat-Pump Installations,** by *Roos J. Martin,* associate professor, mechanical engineering, University of Illinois, Urbana, Ill.

2:30 p.m. Thurs.

### Lubrication (I)

**Oil Flow in Plain Journal Bearings,** by *S. A. McKee,* National Bureau of Standards, Washington, D. C. Paper No. (51—A-34).

**Oil Flow Key Factor in Sleeve-Bearing Performance,** by *Murray Rosenblatt,* engineer, control division, General Electric Company, Schenectady, N. Y., and *D. F. Wilcock,* section engineer, bearings and chemical section, Thomson Laboratory, General Electric Company, West Lynn, Mass.

2:30 p.m. Thurs.

### Applied Mechanics (VIII)

**The Time Required for Constant Volume Combustion,** by *Ashley S. Campbell,* dean, College of Technology, University of Maine, Orono, Maine. Paper No. (51—A-15).

**Recovery Factors and Friction Coefficients for Supersonic Flow of Air in a Tube (Part I),** by *J. Kaye,* associate professor of mechanical engineering *J. H. Keenan,* professor of mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass., *K. K. Klingensmith,* United Aircraft Corporation, East Hartford, Conn., *G. M. Ketchum,* development engineer, thermal power system division, General Engineering Consulting Laboratory, General Electric Company, Schenectady, N. Y., and *T. Y. Toong,* research assistant mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass. Paper No. (51—A-29A).

**Recovery Factors and Friction Coefficients for Supersonic Flow of Air in a Tube (Part II),** by *J. Kaye,* associate professor, *T. Y. Toong,* research assistant, mechanical engineering, and *R. H. Shoulberg,* assistant, mechanical engineering department, mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass. Paper (No. 51—A-29B).

**Gas Cooling of a Porous Heat Source,** by *L. Green, Jr.,* North American Aviation, Inc., Downey, Calif. Paper No. (51—A-32).

5:00 p.m. Thurs.

### Nuclear Energy

**The General Philosophy of Co-Operation Between the Atomic Energy Commission and Industry.**

6:00 p.m. Thurs.

### American Rocket Society Dinner

8:00 p.m. Thurs.

### High-Temperature Steam Generation—Power (XI)—Effect of Temperature on Metals (III)

NOVEMBER IN ATLANTIC CITY IS MILD AND PLEASANT. MEMBERS WHO PLAY GOLF WILL FIND GOOD COURSES NEARBY TO HEIGHTEN THE PLEASURE OF THE ASME 1951 ANNUAL MEETING, TO BE HELD AT CHALFONTE-HADDON HALL HOTEL, NOV. 26–30, 1951

**Behavior of Superheater Tubing Materials in Contact With Combustion Atmosphere at 1350 F,** by *H. A. Blank*, principal metallurgist, *J. H. Jackson*, supervisor of physical metallurgy, and *A. M. Hall*, assistant supervisor, Battelle Memorial Institute, Columbus, Ohio.

**Evaluation of Superheater Tube Materials for Steam Generation at 1100–1500 F,** by *Bela Ronay*, U. S. Naval Engineering Experiment Station, Annapolis, Md.

**Experimental Superheater for Steam at 2000 Psi and 1250 F—Progress Report of Field Operation,** by *F. G. Ely*, consultant, and *F. Eberle*, chief metallurgical engineer, research and development department, The Babcock & Wilcox Company, Alliance, Ohio.

**Effects of Variations in Viscosity of Lubricants Upon Timken OK and Psi Values,** by *I. S. Kolarik*, *C. A. Zeiler*, and *E. M. Kipp*, Aluminum Research Laboratories, Aluminum Company of America, New Kensington, Pa. Paper No. (51—A-35).

8:00 p.m. Thurs.

### Lubrication (II)

**On the Solution of the Reynolds Equation for Slider Bearing Lubrication,** by *A. Charnes* and *E. Saibel*, Carnegie Institute of Technology, Pittsburgh, Pa. Paper No. (51—A-43).

8:00 p.m. Thurs.

### Hydraulic (IV)

*Panel Discussion on Displacement Compressors*

8:00 p.m. Thurs.

### Metals Engineering (III)—Applied Mechanics (IX)

**The Theoretical Analysis of Metal Forming Problems in Plane Strain,** by *E. H. Lee*, associate professor, Brown University, Providence, R. I. Paper No. (51—A-8).

**A Consideration of a Basis for a Workable Theory of Plasticity,** by *Paul F. Chenea*.

**Determination of Principal Plastic Strains,** by *W. E. Cooper*.

## Friday, November 30

9:30 a.m. Fri.

### American Rocket Society (IV)

**Combustion Studies With a Rocket Motor Having a Full-Length Observation Window,** by *Kurt Berman* and *S. E. Logan*, General Electric Company, Malta Test Station, Ballston Spa, N. Y.

**Optical Techniques for Determining the Interior Ballistics of Liquid-Rocket Thrust Chambers,** by *J. D. Thackrey* and *J. H. Altseimer*, development engineers, Aerojet Engineering Corporation, Azusa, Calif.

**Experimental Problems in High-Pressure Combustion,** by *R. L. Wehrli*, chief physicist, Reaction Motors, Inc., Rockaway, N. J.

9:30 a.m. Fri.

### Textile (I)

*Symposium on Opening and Picking*

**Opening and Picking by the Aldrich System,** by *A. P. Aldrich*, president, Aldrich Machine Works, Greenwood, S. C.

**Opening and Picking by the Saco-Lowell System,** by *Robert S. Curley*, research engineer, Saco-Lowell Shops, Biddeford, Maine.

9:30 a.m. Fri.

### Hydraulic (V)

**Flow Through Two Orifices in Series,** by *W. M. Rohsenow*, *C. H. Fink*, and *S. R. Pollis*.

9:30 a.m. Fri.

### Fuels (VIII)—Power (XII)

**Station Design With Cyclone-Fired Steam Generators,** by *H. C. Schroeder* and *R. I. Strasser*, Sargent and Lundy, Chicago, Ill.

**Operating Experiences With Cyclone-Fired Steam Generators,** by *V. L. Stone*, Commonwealth Edison Company, and *I. L. Wade*, Public Service Company of Northern Illinois.

9:30 a.m. Fri.

### Applied Mechanics (X)—Lubrication (III)

**The Calculated Performance of Dynamically Loaded Sleeve Bearings—III,** by *J. T. Burwell*, associate professor, department of mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass. Paper No. (51—A-7).

**An Electrical Method for Determining Journal-Bearing Characteristics,** by *D. S. Carter*, Princeton University, Princeton, N. J. Paper No. (51—A-27).

12:15 p.m. Fri.

### Textile Luncheon

Presiding: *R. O. Palmer*, chairman, ASME Textile Division, Carlyle Johnson Machine Company, Shrewsbury, Mass.

Speaker: *Joseph M. Leahy*, director of research, Volkart Brothers, Inc., New York, N. Y.

Subject: **The 1951 Cotton Crop.**

2:30 p.m. Fri.

### American Rocket Society (V)

**Flow Stability in Small Orifices,** by *R. P. Northup*, General Electric Company, Malta Test Station, Ballston Spa, N. Y.

**Injector Spray and Hydraulic Methods of Rocket-Motor Analysis,** by *Kurt R. Stehling*, rocket research engineer, Bell Aircraft Corporation, Buffalo, N. Y.

**Fluctuations in a Spray Formed by Two Impinging Jets,** by *Marcus F. Heidmann*, aeronautical research scientist, and *Jack C. Humphrey*, NACA Lewis Flight Propulsion Laboratory, Cleveland, Ohio.

**Some Interactions of Splashing Liquid Jets,** by *K. D. Miller, Jr.*, project engineer, The M. W. Kellogg Company, Jersey City, N. J.

2:30 p.m. Fri.

### Textile (II)

**Opening and Picking by the Whitin System,** by *Paul G. Grant, Jr.*, Whitin Machine Works, Whitinsville, Mass.

*Round-Table Discussion on Opening And Picking*

Moderator: *J. J. McElroy*, general manager, Maverick Mills, East Boston, Mass.

## ASME Calendar of Coming Events

**Oct. 11–12**
ASME Fuels and AIME Coal Division Joint Conference, Hotel Roanoke, Roanoke, Va.
*(Final date for submitting papers was June 1, 1951)*

**Nov. 26–30**
ASME Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.
*(Final date for submitting papers was July 1, 1951)*

**March 24–26, 1952**
ASME Spring Meeting, University of Washington, Seattle, Wash.
*(Final date for submitting papers—Nov. 1, 1951)*

**June 15–19, 1952**
ASME Semi-Annual Meeting, Sheraton Gibson Hotel, Cincinnati, Ohio
*(Final date for submitting papers—Feb. 1, 1952)*

**June 19–21, 1952**
ASME Applied Mechanics Division Conference, The Pennsylvania State College, State College, Pa.
*(Final date for submitting papers—Feb. 1, 1952)*

**June 23–27, 1952**
ASME Oil and Gas Power Division Conference, Hotel Statler, Buffalo, N. Y.
*(Final date for submitting papers—Feb. 1, 1952)*

**Sept. 8–11, 1952**
ASME Fall Meeting, Sheraton Hotel, Chicago, Ill.
*(Final date for submitting papers—May 1, 1951)*

**Sept. 8–12, 1952**
ASME Industrial Instruments and Regulators Division and Instrument Society of America Exhibit and Joint Conference, Cleveland, Ohio
*(Final date for submitting papers—May 1, 1952)*

**Sept. 22–24, 1952**
ASME Petroleum Mechanical Engineering Conference, Hotel President, Kansas City, Mo.
*(Final date for submitting papers—May 1 1952)*

**Nov. 30–Dec. 5, 1952**
ASME Annual Meeting, Statler Hotel, New York, N. Y.
*(Final date for submitting papers—July 1, 1952)*

*(For Meetings of Other Societies see page 850)*

THE ASME COLUMBUS SECTION HAS ITS SIGHT SET ON THE ASME 1953 SEMI-ANNUAL MEETING WHEN THE SECTION WILL PLAY HOST TO THE SOCIETY.

(Members of the committee shown working on Semi-Annual Meeting arrangements are [*left to right*] Marion L. Smith and Walter Robinson, past chairman, professors, Ohio State University; John F. Cunningham, Jr., chairman, Spencer Turbine Company; E. B. Lund, secretary-treasurer, chief engineer, Farm Bureau Insurance Company; John Corsiglia, vice-chairman, utilization engineer, Surface Combustion Corporation; James Purdy, assistant supervisor, Battelle Memorial Institute; and, not present in picture, Ralph A. Sherman, assistant director, Battelle Memorial Institute.

The 235 members of the Columbus Section have shown considerable interest during the past year in discussion meetings on topics of special technical interest which have been held in addition to the regularly scheduled Section programs.

Officers of the Professional Divisions organized within the Columbus Section are: Glen Haney, chairman, and Herbert Hazard, vice-chairman, Fuels and Power; O. E. Buxton, Jr., chairman, and Charles Jones, vice-chairman, Heat Transfer; John H. Norton, chairman, and Thomas E. Richards, vice-chairman, Production Engineering; Arthur Sharf, chairman, and Robert L. Cooney, vice-chairman, Machine Design. Much credit is due the vice-chairman of the Section, John Corsiglia, for his efforts in initiating the organization of these Professional Divisions.)

# Twelve Regional Student-Branch Conferences Climax Successful 1950–1951 Season

MORE than two thousand student members of The American Society of Mechanical Engineers, representing most of the 137 student branches of the Society, attended the twelve regional conferences held during February, April, and May of this year. The conference held at the University of Detroit, Region V, had the record attendance of 374.

The conferences were a clear reflection of the students' interest and enthusiasm toward their chosen profession. They presented excellent opportunities for lively discussion of means which could best be employed to promote more active interest in professional development and student participation in current local student-branch activities on their respective campuses. Membership in professional societies was a topic given much consideration.

### Prize Papers of High Quality

The prize papers were of high quality and the arrangements made by the hosts for the presentation of the papers resulted in sessions of dignity and programs which ran smoothly. The question of scoring papers was taken up and in some quarters it was suggested that all students attending the conference be provided with scoring sheets in order that they might all have experience in evaluating papers even though their scores would not be considered in the official tally.

One of the features of Region I conference was the talk given by George Rietz, manager of Educational Service Division, General Electric Company, Schenectady, N. Y., on "The Young Mechanical Engineer's Future in Industry." Reino Merkallio, Cornell University, whose paper won first prize at the Region III conference, also received the Woman's Auxiliary, Philadelphia Section, ASME, special award of $50. Mrs. Frank W. Miller represented the Auxiliary.

Region IV held its conference in conjunction with the ASME Spring Meeting. It was announced that the Max Toltz Loan Fund to students is not being used to its maximum availability. Although the need for a larger student membership was discussed, the motion to make it mandatory that a student belong to an engineering organization while in college was unanimously opposed.

"Not enough students are competing for the many awards available to student members of the Society," was a point taken up by A. C. Pasini, ASME vice-president, Region V, who added that "schools should foster interest in these awards." He spoke on the work of the student-branch committees, the facilities at the disposal of the students, and went on to point out that the honorary chairmen are the front line of the ASME in the schools. Other suggestions were to encourage closer co-operation between the ASME Sections and the student branches through speakers, joint meetings, and work to form an Engineering Student Council.

At the Southern Tier, Region VI conference, it was agreed that the location of the meeting is to be determined by the host, but every effort should be made to use a city where hotel facilities and inspection trips are available.

The high light of the Region VII, Pacific Northwest Conference was the talk given by E. B. MacNaughton, president, Reed College. His timely and enthusiastically-received talk was on "The Young Engineer Faces Tomorrow."

### Advanced Registration Favored

The Northern Tier, Region VIII conference, held in Kansas City, Mo., was held in conjunction with the ASME Region VIII Annual Meeting. An advanced registration was conducted before the conference. For those registering in advance, hotel accommodations were reserved, joint luncheon tickets, field-trip tickets and so on were obtained. These tickets and reservations were ready for the student on his arrival in Kansas City. Pres. J. Calvin Brown was speaker at the joint Student-Member Luncheon. A panel discussion was held during the conference on "Problems Facing the Graduating Engineer" conducted by the students. The response to the topics chosen was tremendous and both students and members took part.

From the general response it is evident that the field inspection trips are always popular and well attended. The consensus is that the student conferences which are held in connection with the big meetings of the Sections or the National Meetings of the Society encourage larger attendance by the students. In all, the conference reports there were expressions of gratitude and appreciation to the schools serving as host for their hospitality and the warm reception extended to the visitors.

The list of prize-winning papers and authors appears on the following page. Précis of some of the prize-winning papers follow:

## Region I

### A Comparison of the Surfaces Produced by Honed Versus Ground Broaches

**By William J. Miller, Jr.**[1]

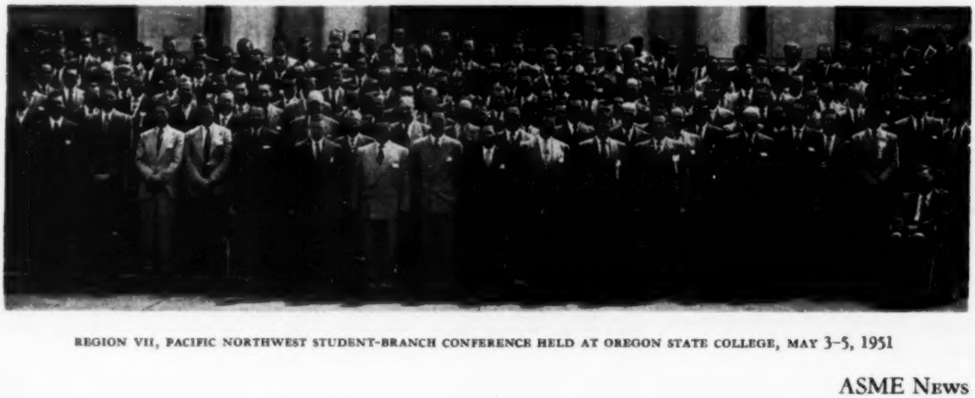
NINE high-production broaching operations were studied for a comparison of surface finishes produced by ground and honed broaches. Sharpening methods selected for test were dry-grinding, wet-grinding, and honing. Early in the studies it was discovered that dry-grinding caused considerable reduction in tool life. The tests were therefore conducted on wet-grinding and honing.

Long-term studies were made on actual production runs. In some cases the results produced by use of a ground broach were compared with that of a honed one in simultaneous operations on similar parts. Where this ideal condition did not exist, broaches were ground for one run and honed for the next.

The average of all surfaces produced by honed broaches was 17.8 microinches. The range or spread in which 99 per cent of all parts can be expected to fall is 0 to 41 microinches. The average of all surfaces produced by ground broaches was 22 microinches. The range or spread in which 99 per cent of all parts can be expected to fall is 0 to 47 microinches.

The results did not bear out a preliminary

[1] Student Member, ASME, Rensselaer Polytechnic Institute, Troy, N. Y.



REGION VII, PACIFIC NORTHWEST STUDENT-BRANCH CONFERENCE HELD AT OREGON STATE COLLEGE, MAY 3–5, 1951

# 1951 ASME Regional Student Conference Prize Winners

REGION I, NEW ENGLAND, UNIVERSITY OF VERMONT, BURLINGTON, VT., APRIL 20–21, 1951

Attendance: 173 — Papers Presented: 8

| *Prize* | *Recipient* | *Title of Paper* | *College* |
|---|---|---|---|
| First | William J. Miller, Jr. | Product Surface Finishes Produced by Different Broach-Sharpening Procedures | Rensselaer Polytechnic Institute |
| Second | George S. Reischenbach | Testing of a Miniature Internal-Combustion Engine | Yale University |
| Third | Ralph W. Preston | Building Ships in Bottles | University of Vermont |
| Fourth | Philip Levine | An Experimental Analysis of Flame Propagation in Cylindrical Tubes | University of Connecticut |
| Old Guard | Robert L. Schaeffer | The Practical Application of the Hilsch Tube | Clarkson College of Technology |

REGION II, EASTERN, STEVENS INSTITUTE OF TECHNOLOGY, HOBOKEN, N. J., MAY 5, 1951

Attendance: 110 — Papers Presented: 9

| *Prize* | *Recipient* | *Title of Paper* | *College* |
|---|---|---|---|
| First | David Findlay | Design Aspects of the Gas-Operated Semiautomatic Rifle | Stevens Institute of Technology |
| Second | Mark Levine | Diesel Engines | Polytechnic Institute of Brooklyn (Day) |
| Third | Joseph Schatz | The Design, Construction, and Cost of Fuel Additive Injection Apparatus | Pratt Institute |
| Fourth | Edwin L. Marshall | Arc-Welded Design for Light Farm Tractors | New York University (Day) |
| Old Guard | Henry J. Stumpf | Impeller-Blade Design of Maximum Strength and Minimum Weight | Newark College of Engineering |
| Old Guard | Michael A. Papillo | Interferometry Analysis | College of the City of New York |

REGION III, ALLEGHENIES, UNIVERSITY OF PENNSYLVANIA, PHILADELPHIA, PA., APRIL 20–21, 1951

Attendance: 176 — Papers Presented: 13

| *Prize* | *Recipient* | *Title of Paper* | *College* |
|---|---|---|---|
| First | Reino Merkallio | Industrial- and Administrative-Engineering Techniques Applied to the Operation of a Lunch Route | Cornell University |
| Second | Carl H. Builder | The Feasibility of a Combination Reaction Engine | U. S. Naval Academy Midshipman School |
| Third | Robert M. Langmack | Solving Trigonometric Problems Without the Aid of Tables | University of Maryland |
| Fourth | Jay S. Wiener | Design and Development of an Emergency Hydraulic Valve | Syracuse University |
| Old Guard | Harold S. Kircher | Application of Cutting Fluids | Bucknell University |

REGION IV, SOUTHERN, GEORGIA INSTITUTE OF TECHNOLOGY, ATLANTA, GA. (IN CONJUNCTION WITH SPRING MEETING), APRIL 2–3, 1951

Attendance: 181 — Papers Presented: 12

| *Prize* | *Recipient* | *Title of Paper* | *College* |
|---|---|---|---|
| First | Kenneth W. Whittington | The Hydrocal—A Hydraulic Analog | University of Florida |
| Second | Arthur W. Jenkins | Pneumatic Ash Conveying | University of Virginia |
| Third | William E. Durham | The Unicel Box Car | Virginia Polytechnic Institute |
| Fourth | John F. Steedley, Jr. | Opportunity or Security | Georgia Institute of Technology |
| Old Guard | J. Daniel Martin | Ranque's Tube | Duke University |

REGION V, MIDWEST, THE UNIVERSITY OF DETROIT, DETROIT, MICH., APRIL 30–MAY 2, 1951

Attendance: 374 — Papers Presented: 11

| *Prize* | *Recipient* | *Title of Paper* | *College* |
|---|---|---|---|
| First | Archibald Newton | Fuel Injection Applied to Gasoline Sparks Engine | Carnegie Institute of Technology |
| Second | George Criswell | The Advantages and Applications of Heliarc Welding | University of Akron |
| Third | Charles G. Duff | The Magnetic Recording of Sound | University of Toronto |
| Fourth | Lewis Pollock | Photography as a Tool for the Engineer | University of Pittsburgh |
| Old Guard | Clinton Jaycox | The Design and Construction of a Vertical Hydrogen Furnace | University of Michigan |

REGION VI, NORTHERN TIER, ILLINOIS INSTITUTE OF TECHNOLOGY, CHICAGO, ILL., MAY 7–8, 1951

Attendance: 220 — Papers Presented: 12

| *Prize* | *Recipient* | *Title of Paper* | *College* |
|---|---|---|---|
| First | Gordon F. Kingsley | Wheels Without Axles | Northwestern University |
| Second | Robert L. Jondahl | Production of Untapped Energy | University of North Dakota |
| Third | Walter G. Blank | Design of a Hydraulically Actuated Loader | Iowa State College |
| Fourth | William R. Pearce | The Young Engineer on the Lakes | Michigan College of Mining & Technology Houghton Division |
| Old Guard | Wilfred L. Steuerwald | Practical Problems of Design | South Dakota State College |

REGION VI, SOUTHERN TIER, UNIVERSITY OF ILLINOIS, PEORIA, ILL., APRIL 26, 27, 1951

Attendance: 164 — Papers Presented: 8

| *Prize* | *Recipient* | *Title of Paper* | *College* |
|---|---|---|---|
| First | Forest D. Bailey | Medical Engineering | State University of Iowa |
| Second | Paul J. Williams | Infinitely Variable Hydrostatic Hydraulic Transmissions and Their Automotive Applications | Purdue University |
| Third | Roy A. Moody | Design, Construction, and Operation of a Model 4-Stroke-Cycle Engine | Rose Polytechnic Institute |
| Fourth | Walter Meibaum | Heating Coil for a Home Furnace | Washington University |
| Old Guard | Lloyd K. Jacobs | The Moduflow Control System | University of Kentucky |

REGION VII, PACIFIC NORTHWEST, OREGON STATE COLLEGE, CORVALLIS, ORE., MAY 3–5, 1951

Attendance: 180 — Papers Presented: 11

| *Prize* | *Recipient* | *Title of Paper* | *College* |
|---|---|---|---|
| First | Robert Kemper | Inert-Gas Arc Welding of Zirconium | Oregon State College |
| Second | David Resner | The Earth as a Source of Heat | Washington State College |
| Third | Don Jacobs | An Electric Torque Converter | University of Washington |
| Fourth | Al Cronk | Blanking Dies | University of British Columbia |
| Old Guard | Richard Gardner | A Wind Tunnel for Testing Precipitation Gages | University of Idaho |

REGION VII, PACIFIC SOUTHWEST, UNIVERSITY OF SOUTHERN CALIFORNIA, LOS ANGELES, CALIF., APRIL 20, 21, 1951

Attendance: 44 — Papers Presented: 11

| *Prize* | *Recipient* | *Title of Paper* | *College* |
|---|---|---|---|
| First | Wayne M. Beebe | A New Method for Reduction of 45° Rosette Strain Data | California Institute of Technology |
| Second | Russell Romney | Construction of a Portable Astronomical Telescope | University of Utah |
| Third | James Devendorf | The Use of Residual Fuels in Diesel Engines | University of Southern California |
| Fourth | Robert Bloom | The Advantage of Water Injection in Internal Combustion | Stanford University |
| Old Guard | Donald Briggs | The Influence of Size and Number of Stress Reversals in the Internal Damping of Metals | University of Santa Clara |

REGION VIII, NORTHERN TIER, JUNIOR ENGINEERS' CLUB OF KANSAS CITY, KANSAS CITY, MO., APRIL 16, 17, 1951

Attendance: 163 — Papers Presented: 14

| *Prize* | *Recipient* | *Title of Paper* | *College* |
|---|---|---|---|
| First | Keith R. Cossairt | Smoke-Tunnel Studies | University of Nebraska |
| Second | Gerald H. Frieling | Two-Valve Water Faucet | University of Kansas |
| Third | John E. Olsson | Automatic Combustion Control | University of Nebraska |
| Fourth | Lloyd B. Sharpsteen | Progress in the Design of Passenger Elevators | Kansas State College |
| Old Guard | William D. Gammill | Dry-Cleaning Methods and Equipment | University of Arkansas |

REGION VIII, ROCKY MOUNTAIN TIER, UNIVERSITY OF WYOMING, LARAMIE, WYO., APRIL 27–28, 1951

Attendance: 124 — Papers Presented: 13

| Prize | Recipient | Title of Paper | College |
|---|---|---|---|
| First | Wayne McNeely | Vibration Isolation of Natural-Gas Compressor Units | Colorado School of Mines |
| Second | Charles E. Gaddis | The Keys to Power | University of New Mexico |
| Third | Virginia Gaddis | A Method of Eliminating Knock in Internal-Combustion Engines | University of New Mexico |
| Fourth | Carrol D. Daniels | The Texaco Combustion Process | University of Wyoming |
| Old Guard | Richard W. Rausch | The Iron and Steel Industry of the Middle Ages | University of Wyoming |

REGION VIII, SOUTHERN TIER, LOUISIANA STATE COLLEGE, BATON ROUGE, LA., FEBRUARY 23–24, 1951

Attendance: 122 — Papers Presented: 14

| Prize | Recipient | Title of Paper | College |
|---|---|---|---|
| First | Charles E. Davis | Automotive LPG Conversion Units | University of Texas |
| Second | Raymond L. Lankford | Flame Hardening of Steel | Rice Institute |
| Third | James E. Campbell | The Talgo Train | University of Texas |
| Fourth | Hubert P. Davis | Electric Strain Gages | Texas A&M College |
| Old Guard | Philo H. DuVal, Jr. | Cathodic Protection of Oil Pipe Lines | Texas A&M College |

spot check which indicated that ground broaches were even less satisfactory than the results shown. The good showing of the ground broaches may be due in part to the more careful sharpening of the test broaches because it was not possible to keep the tests secret from the toolmakers.

In some of the runs honing of the broach did not improve results obtained.

## Region II

### Design Aspects of the Gas-Operated Semiautomatic Rifle

**By David Findlay**[2]

IN a semiautomatic rifle the energy required to extract and eject the cartridge, to cock the firing mechanism, and to compress the spring which forces the bolt forward is usually obtained by expanding some of the high-compression powder gas in a piston. When the piston is forced rearward, its motion is transmitted to the bolt.

The simplest method of tapping powder gas for expansion in the gas cylinder is by means of a small hole in the barrel. Because powder deposits a carbon residue and because potassium primer salts tend to be corrosive, carbon often clogs the gas port and causes the weapon to operate sluggishly.

More complicated methods have been devised by Russian and Swedish firearms designers with various degrees of success, but none is as effective as the relatively loose-fitting piston design of the United States M1 Garand rifle. The M1 opens with extreme rapidity, yet the design is reliable and functions superbly, and it is doubtful whether an attempt will be made to change the gas-piston design in light of European developments.

The receiver, bolt, and barrel face of the semiautomatic rifle present another important design problem. Extremely high pressures in the neighborhood of 55,000 psi must be contained to prevent rearward gas escape that might injure eyes of operators. In this respect the Garand M1 rifle is notably successful. Over four million have been manufactured without failure in this respect.

The cartridge-supply system is another major design problem of the semiautomatic rifle. Such a system must readily supply loaded rounds as fast as firing rate causes them to be expended. The most common feed system for automatic weapons is the stamped sheet-steel box magazine. The feed surfaces are lips stamped integrally with the magazine body. The lips are very easily deformed under field-service conditions, but the magazine is readily manufactured. The box magazine is easily designed to be instantly inserted and removed from the weapon. The best system has been designed by Captain Melvin M. Johnson, Jr., U.S.M.C.R. (inactive). It consists of a stamped box, but the feed surfaces are machined in the receiver, eliminating the fragile stamped lips. Captain Johnson further arranged the system to be recharged with fresh cartridges at any time. The cartridges are contained in the magazine by a simple spring-steel clip which is forced aside when the magazine is fully inserted.

[2] Student Member, ASME, Stevens Institute of Technology, Hoboken, N. J.

## Region III

### The Application of Industrial Engineering to an Evening College Dormitory Snack Service

**By Reino A. Merikallio**[3]

BY applying the principles of industrial engineering to the deceptively elemental business of a college-dormitory snack service, student vendors were able to increase their sales and therefore their wages nearly threefold.

This service reflects a wide variety of business problems embracing the whole range of industrial engineering, including plant layout, production planning, methods and time study, market research, statistics, economics, psychology, and even thermodynamics.

Operation of the business involved two men who, between the hours of 7:45 and 11:45 p.m., assembled their wares, packed sandwiches, called on dormitories, unloaded wares, checked sales, and predicted demand for the following day.

One of the chief challenges of the operation was the mass production of 200 sandwiches, the sale of which yielded one third of the gross revenue. A methods- and time-study operation on sandwich making made it possible for the vendors to reduce loading time from 150 to 90 man-minutes.

Since the wages were the main incentive in the operation, it was necessary to devote maximum effort in market research to learn when and where on the campus the greatest demand occurred. Based on these facts it was possible to sell wares in the most lucrative dormitory during the most lucrative selling hours.

Because each vendor carried a total weight of 80 pounds of wares, some of which required replenishing, the location of parking spaces was an important consideration. Much waste time was eliminated by scheduling several low-demand dormitories between return trips to the trucks for refilling snack baskets.

The most challenging aspect of the snack business was predicting food requirements for the next day. Statistical analysis was brought to bear on the complex variables which affected dormitory appetites. Checks from home, physical fatigue after week ends, Sunday movies, extracurricular activities on certain nights, could be counted on to buoy or depress sales. The weather was an important determinant. In winter, when students were bedded down in dormitories, sales increased. Rain was also good for business.

By keeping track of all these factors and by using a well-oiled Ouija board, student vendors increased their wages, based on 10 per cent of sales, from $4 to $11 for the daily four-hour work period.

[3] Student Member, ASME, Cornell University, Ithaca, N. Y.

## Region IV

### The Hydrocal—A Hydrodynamic Calculating Machine

**By Ken W. Whittington**[4]

THE hydrocal is a hydrodynamic calculating machine designed to solve unsteady-state heat-transfer problems. The hydraulic circuit of the machine is designed to set up such elements of heat transfer as thermal resistance, heat flow, temperature difference causing the flow, and thermal storage. The machine consists of a variable-head tank, glass stand pipes to serve as capacitors, resistance valves with interconnecting pipes, and a weight tank.

When the machine is properly set up, representing a specific heat-transfer problem, flow of fluid is analogous to heat flow.

Water was first intended as the fluid for the hydrocal but this was changed to a sugar solution when it was discovered that pure water under certain conditions of heat causes turbulent flow in the resistance valves. Turbulent flow was objectionable because it introduced complications which upset the analog.

[4] Student Member, ASME, University of Florida, Gainesville, Fla.

A comparison of results obtained from the analog with those obtained by the American Society of Heating and Ventilating Engineers laboratory, showed that the analog gave excellent results. The test problem was to find instantaneous heat flow under operating conditions. The solution of the problem by hydrocal was 2.02 per cent higher than that obtained from tedious mathematical analysis.

The hydrocal is a versatile piece of equipment which can eliminate some time-consuming mathematical computation in the field of heat transfer.

## Region V

### Fuel Injection Applied to Gasoline Spark-Ignition Engines

**By A. R. Newton**[5]

ONE of the solutions to the problem of equalizing fuel-air distribution among the cylinders of a gasoline spark-ignition engine is a form of multiple carburetion consisting of a fuel-injection system which delivers to the intake valve of each cylinder a predetermined quantity of fuel. The advantages of such a fuel-injection system was studied at the Carnegie Institute of Technology. Tests were made with a German-built Bosch constant-displacement-type injection pump applied to an Army-type portable engine a-c generator unit with a four-cylinder, L-head 123-cubic-inch engine.

During the comparative tests, every effort was made to eliminate as many variables between the two systems as possible. In changing from the standard carburetor to the injection system, no change was made in the valve settings, spark adjustment, or fuel characteristics.

The tests gave ample evidence of the superior performance of the engine when using fuel injection. A five per cent gain in fuel economy was noted. This gain was more apparent at high engine speeds but at all speeds a drop in specific fuel consumption was as much as seven per cent. The gain in fuel economy was the result of equalizing fuel distribution to each cylinder. No longer was an overrich mixture from the carburetor required to assure an adequate fuel supply to the formerly leaner cylinders.

With fuel injection each cylinder received only as much fuel as it needed to deliver the power requirement.

Other advantages of the system the tests showed were easier engine starting, especially under conditions of extremely low temperature, elimination of carburetor icing, better acceleration characteristics under heavy load conditions, and elimination of vapor lock when operating under conditions of extreme heat.

While the fuel-injection idea applied to ground transportation is fairly new, it is backed by 25 years of use in aviation. Fuel injection applied to automobiles offers many opportunities for improving the engines of tomorrow.

[5] Student Member, University of Detroit, Detroit, Mich.

## Region VII

### Inert-Gas Arc Welding of Zirconium

**By Robert S. Kemper, Jr.**[6]

ZIRCONIUM, with its high melting point, attractive strength-weight ratio, excellent corrosion resistance, and good ductility, is of interest to the aircraft, surgical-instrument, and physics fields. The affinity of oxygen and nitrogen for zirconium above 860 C, however, is responsible for the problems encountered in welding this material. Gas absorption during the welding operation results in brittleness and a complete breakdown of the metal structure.

An investigation of the weldability of zirconium conducted by the author showed that when the metal is welded by using argon gas and the shielded-tungsten arc welding process, satisfactory bonds can be achieved. Based on impact, bending, hardness tests, and x-ray and metallographic studies, the following conclusions were drawn: No evidence of oxygen or nitrogen penetration could be found in the welded specimens and, since fracture occurred in approximately the same section of each, the grain structure at this point is evidently responsible for low strength values. Incomplete fusion on the direct tensile specimens decreased the ultimate strength also. Annealing to produce a more uniform structure and to break up the carbide chains found in the residual beta grain boundaries would probably relieve these stress risers.

Little reduction in impact strength was found in the weld deposit. The bend ductility was appreciably reduced in the heat-affected zone adjacent to the weld deposit.

Extreme care must be taken to control the atmosphere during the welding of zirconium and inert-gas arc welding provides the most practical method for this control. Additional flow of inert gas is necessary to prevent oxidation of the underside of the weld.

Further work with carbon-free metal as produced by the arc melting process would determine the effect of the carbide segregation observed in these tests.

[6] Student Member, ASME, Oregon State College, Corvallis, Ore.

## Region VII (Northwest)

### A New Method for Reduction of 45-Deg Rosette Strain Data

**By Wayne M. Beebe**[7]

THE "rectangular rosette" is a variation of a wire strain gage which has been found useful in stress-analysis work to indicate principal strains in stressed material.

Until 1947 there were three basic methods for reducing measured strain data for principal stresses and directions (1) Direct arithmetical computation; (2) graphic solution using nomographs; and (3) automatic solution using electronic computers. None of these methods was satisfactory because the first, while accurate, was tedious, and the second, while relatively fast and efficient, was not sufficiently accurate; and the third, while efficient and accurate, was prohibitively expensive. This paper discusses the theory and describes the construction of a stress-strain slide rule which offers a fourth method for reduction of rosette strain data.

Use of the new slide rule cuts the time for

[7] Student Member, ASME, California Institute of Technology, Pasadena, Calif.

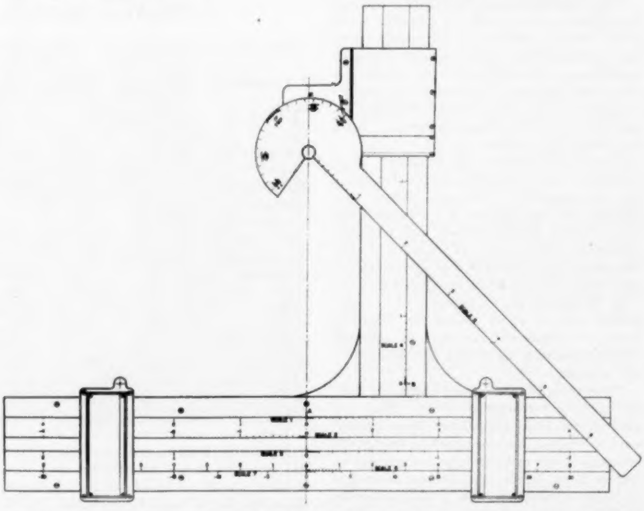


FIG. 1 SPECIAL SLIDE RULE DESIGNED AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY TO REDUCE 45° ROSETTE STRAIN-GAGE DATA TO PRINCIPAL STRESSES AND DIRECTIONS

computing principal stresses for 24 rosettes from four hours to three quarters of an hour, allowing one man with the slide rule to keep abreast easily of several men taking data. Cost of the slide rule is several hundred dollars.

The idea of building a stress-strain slide rule was conceived by engineers of Vickers-Armstrong, Limited, in 1947. Shortly after, the California Institute of Technology became interested in the design of an accurate machine for reducing such data. The scales of the new slide rule were so arranged that the various steps in the reduction of rosette data could be done with the least amount of thought and manipulation. In ordinary practice, strains measured by a single gage of a rosette are recorded as changes in voltage across a Wheatstone-bridge circuit. The indicated voltage is then used to compute what is called "apparent strain" and the apparent strains in the directions of the three gages are used to compute magnitudes and directions of principal stresses. Fig. 1 shows the physical factors of the stress-strain slide rule.

## Region VIII (Rocky Mountain)

### Vibration-Isolation of Natural-Gas Compressor Units

**By Wayne E. McNeely**[8]

SOME natural-gas compressor units are known to expend from three to ten per cent of energy developed in vibrating compressor foundations, areas around foundations, and enclosing structures. This wasted energy introduces potential danger to delicate instruments and causes physical fatigue of workers in the vicinity.

Vibration is defined as the limited reciprocal or oscillatory motion of the particles of an elastic body or medium, in alternately opposite directions from their positions of rest or equilibrium. A compressor unit develops a vibrational frequency approximately equal to its speed. These vibrations are amplified by friction and by dynamic unbalance of parts rotating about a center.

During acceleration the frequency of a compressor may reach the natural frequency of the supporting structure. When this happens, the unit vibrates at a maximum and may damage the foundation and retaining structure. If this period of resonance is near the operating speed of the unit, severe damage may result from continuous operation.

By designing the foundation of a compressor unit so as to isolate the vibration source, a compressor unit may be operated without transmitting damaging vibration to the structure.

Three types of material are commonly used for effecting vibration isolation. These are steel springs, cork, and rubber. Steel springs, used to support a platform which carries the compressor unit and to which is suspended an inertia block, is the most efficient method of isolating vibration because elastic properties can be accurately predicted and effectively controlled.

Cork molded as resilient sheets or blocks, then compressed and baked under prescribed pressures and temperatures, produces a material strong and enduring which retains its physical characteristics indefinitely when correctly used.

Pure gum rubber in sheets and blocks is gradually being replaced by a material composed of a combination of rubber and cork.

Two general methods of isolation are commonly used. In the first, a layer of isolation material is applied to a concrete foundation pit into which additional concrete is poured to form the inertia block support of the compressor unit. This method is economical and effective for heavy machinery.

For lighter machinery a simpler method is used in which isolation material is applied directly between the compressor base plate and the floor to which it is attached.

Greater isolation of compressor units permits greater unit output, reduced building and foundation construction costs, reduced repair costs, more efficient machinery arrangement, and better worker safety and health environment.

[8] Student Member, Colorado School of Mines, Golden, Colo.

## Region VIII (Southern)

### Automotive LPG Conversion Units

**By Charles E. Davis**[9]

THE principal advantages of butane as a low-pressure gaseous fuel for use in automotive internal-combustion engines are reduced cost of operation, higher octane ratings of the fuel, absence of carbon formations, and reduced crankcase dilution. Butane costs about 10 cents per gallon and will deliver 70 per cent of the mileage possible from a gallon of gasoline. At high compression ratios, performance of butane is equivalent to that of gas. Little or no carbon is formed from gaseous fuel, and oil need be changed only once per year.

The only disadvantage of the fuel is the difficulty of obtaining it at night and on holidays. The fuel is readily available during the day.

The paper describes a conversion unit consisting of a fuel tank, a filter, butane regulating unit, and a Diesel-fuel carburetor. The butane enters the filter as a liquid at 100 F and 59 psi and leaves the regulator as a dry gas slightly below atmospheric pressure. The gaseous butane then enters the Diesel-fuel carburetor where it is mixed with a proper amount of air and passed to the engine intake manifold. The fuel tank in the experimental installation had a capacity of 25 gallons and a working pressure of 250 psi. It was installed in the rear compartment of the car. All openings in the tank except the safety valve had automatic valves built inside the tank to shut off flow in case of a fuel-line break or if rate of flow became excessive.

The change from gasoline to butane operation in an automobile fitted with a conversion unit is a simple one. On the installation described the change-over was accomplished by solenoid valves. It was done without stopping the car.

[9] Student Member, University of Texas, Austin, Texas.

# ASME Standards Workshop

### Instrument Screw Threads

THAT American manufacturers of instrument fastening screws are prepared to accept any approved standard for such fastenings is the opinion of Subcommittee No. 4 for Instrument Screw Threads of the Sectional Committee B1 on Standardization and Unification of Screw Threads.

This Subcommittee met at the Hamilton Watch Company, Lancaster, Pa., May 24, 1951, to consider a draft of a proposed standard. E. W. Drescher, vice-chairman of the Subcommittee, presided. Others present were F. E. Richardson, chairman; R. A. Frye; F. X. Lamb, alternate for J. H. Miller; A. C. Millard; D. R. Miller; E. H. Schaeffer; C. E. Smart; G. Spiller, alternate for P. F. Weber; K. T. Vande; D. F. Viles; and H. R. Cobleigh.

At the Ottawa conference in 1945, delegates from Canada, Britain, and the United States had agreed to accept as a basis for unification of screw threads used for instrument fasteners, the screw-thread series recommended by the National Horological Society.

The aircraft industry and the Signal Corps are pressing for a standard for small screws according to Mr. Miller. Several screw companies, it was reported, had been receiving inquiries about small screws but have deferred initiating a new thread standard for their products with the hope that a generally acceptable standard may soon be formulated.

Mr. Drescher reported that the Hamilton Watch Company had studied the recommendations of the Ottawa conference and has used the NHS series of diameters and pitches from 30 to 90 NHS in all of its new products since 1947. The Hamilton Watch specifications, he said, include the 50-deg thread angle of the NHS series. He said they have found it was more difficult to make threading tools to cut narrower crest flat of the 60-deg form.

It was the consensus that while the 60-deg angle should still be considered, the fact that millions of threaded components produced by the Hamilton Watch Company using the 50-deg form has given ample evidence of its practicability.

Mr. Drescher submitted a draft for a standard on instrument fastening screw threads which was discussed in detail by the Subcommittee. The Subcommittee agreed to

draw up a proposal using the 50-deg thread form for all sizes up to and including 90 NHS.

## Standards Week

THE week of October 22 has been selected as Standards Week by ASME Standardization Committee. Approximately 15 sectional committees and subcommittees, for which the ASME is administrative sponsor, plan to meet in the Engineering Societies Building, New York, N. Y., to carry on the work that normally is scheduled for the ASME Annual Meeting.

The decision of many committees to meet in New York rather than in Atlantic City was taken to relieve the pressure under which committeemen must work at an annual meeting. Normally, 20 standardization committee meetings are scheduled within the five-day period. Because of committee responsibilities, many ASME standards workers are unable to attend technical sessions of interest to them.

By dividing committee work between New York and Atlantic City it is expected that the Annual Meeting standards committee schedule will be reduced by one half.

The following standards committees expect to hold meetings in New York: B1, Standardization and Unification of Screw Threads; B6, Gears; B16, Pipe Flanges and Fittings; B17, Shafting; B18, Dimensional Standardization of Bolts, Nuts, Rivets, Screws, and Similar Fasteners; B27, Plain and Lock Washers; B32, Wire and Sheet Metal Gages; Y14, Standards for Drawing and Drafting Room Practice; Y15, Graphical Presentations and others.

The week of October 22 was chosen because it is also the week of the annual meeting of the American Standards Association and many ASME committeemen will be in New York to attend this event.

## Interpretations of Code for Pressure Piping

FROM time to time certain actions of the Sectional Committee B31 will be published for the information of interested parties. While these do not constitute formal revision of the Code, they may be utilized in specifications, or otherwise, as representing the considered opinion of the Committee.

Pending revision of the Code for Pressure Piping, ASA B31.1-1951, the Sectional Committee has recommended that ASME, as sponsor, publish selected interpretations so that industry may take immediate advantage of corresponding proposed revisions. Case Nos. 6, 7, 8, and 9 are published herewith as interim actions of Sectional Committee B31 on the Code for Pressure Piping that will not constitute a part of the Code until formal action has been taken by the ASME and by the American Standards Association on a revision of the Code.

### Case No. 6

*Inquiry:* In view of the publication of the new American Petroleum Institute Standard API-600 February, 1951, containing Tables 18 and 19 having increased pressure-temperature ratings for 4–6 per cent chrome steel to ASTM A217-C5 and ASTM A182-F5 over those now shown in Tables 19 and 20 of Section 3, Oil Piping of the Code for Pressure Piping, may these increased ratings be used for valves, flanges, and fittings made of these materials in oil piping applications?

*Reply:* It is the opinion of the Committee that pending a general revision of the Code, the pressure-temperature ratings shown in Tables 17 and 18 (pages 48 and 49, respectively) for the temperature range of 100 to 750 F may be substituted for the values shown in Tables 19 and 20 (pages 50 and 51, respectively) for the same temperature ratings.

ASME B1 SUBCOMMITTEE NO. 4 WHICH MET AT THE HAMILTON WATCH COMPANY, LANCASTER, PA., MAY 24, 1951

(*Front row, left to right:* A. C. Millard, E. H. Schaeffer, E. W. Drescher, H. R. Cobleigh, and D. R. Miller. *Second row:* K. T. Vande, F. E. Richardson, R. A. Frye, and C. E. Smart. *Back row:* D. F. Viles, and F. X. Lamb. Mr. G. Spiller, who also attended the meeting, is not in the picture.)

### Case No. 7

Explanatory Note: The Sectional Committee on the Code for Pressure Piping wisely decided to co-ordinate its work in the field of establishing maximum allowable stresses for materials with that of the ASME Boiler Code Committee, and through proper liaison, representative members of the Code for Pressure Piping have been serving also as members of the Boiler Code Subcommittee on Stress Allowances for Ferrous Materials in order that the fundamental work on the properties of the materials might be carried on most expeditiously and without duplication of effort.

This committee has leaned heavily on the data contained in the Miller-Hager Report (ASTM Publication No. 100), but has supplemented this report by additional data submitted by other research groups. After long and careful deliberations, the committee selected values for ultimate strength, yield strength, creep rate, and stress rupture, which in their combined judgment represented values for these properties that could be used by code-writing authorities in establishing safe working stresses. With this work done, it then became the responsibility of the individual code committees to select the factors that should be applied to these physical properties for determining the maximum allowable working stress for the code or code section in question.

Section I of the Code for Pressure Piping deals with power piping, and for this section the following statement has been adopted. "The maximum allowable working stresses shall be established as the lowest of the following stresses: (A) $^1/_4$ of the minimum specified tensile strength; (B) $^1/_4$ of the tensile strength at temperatures as reported by test data; (C) $62^1/_2$ per cent of the yield strength at temperature as reported by test data; (D) A conservative average of the stress to give a creep rate of 0.01 per cent in 1000 hours as reported by test data."

Since a table of stresses computed on the basis given above appeared on page 676 of the August, 1951, issue of Mechanical Engineering, it is not being reproduced here.

Sectional Committee B31 has taken action to publish Case No. 7 to make the most recently developed stresses available to manufacturers of pressure piping.

*Inquiry:* In view of the fact that the ASME Boiler Code Committee has adopted new stress values for Section 1 of the ASME Boiler Construction Code some of which are higher than those now permitted in Tables 3 and 3*a*, are these increased stresses permissible under Section 1 of the Code for Pressure Piping?

*Reply:* It is the opinion of the Committee that pending revision of Tables 3 and 3*a*, the revised stresses given in Table P-5, Section 1, of the ASME Boiler Construction Code may be used for piping under Section 1 of the Code for Pressure Piping.

### Case No. 8

*Inquiry:* May alloy-steel tubing with flared fittings be used in the area where seamless steel pipe with socket welding fittings is now specified?

*Reply:* It is the opinion of the Committee that alloy-steel tubing of adequate wall thickness and flared or welding fittings, are permissible in this area, providing in the case of flared fittings, a satisfactory flare can be made.

**Case No. 9**

*Inquiry:* What temperature should be used for designing instrument piping beyond the shutoff valve at the source connection?

*Reply:* Tests indicate that the temperatures in the connecting lines beyond the shutoff valve at the source connection are always lower than the saturated steam temperature corresponding to the main-line pressure. It is the opinion of the committee that the design temperature for connecting lines beyond the source valve need not exceed the saturation temperature corresponding to the main-line pressure.

In no case, however, shall the design temperature exceed the limits for the material as prescribed in the Code.

# Junior Forum

## Forum Welcomes 1951 Juniors

THE National Junior Committee of The American Society of Mechanical Engineers welcomes into the professional ASME family juniors who have left the campus in 1951.

By this time these men are settled in their new communities and are weathering the first experiences of life in industry. Probably they have already attended their first local Section meeting, have introduced themselves to Section officers, and are well on their way to some assignment for the Section.

But for all juniors, whether they find themselves in a populous industrial center among many professional colleagues or in some smaller town where professional-society activity is infrequent, the National Junior Committee inaugurates for the fifth year its own section in MECHANICAL ENGINEERING. These columns provide a forum in which younger members of the Society can explore and develop in their own way, means by which the ASME can better serve them, and in turn benefit more directly from the ideas and enthusiasm of its younger members.

### Committee Serves Juniors

The National Junior Committee is the functioning body within the ASME through which the junior member can improve his lot. This group assures proper presentation and treatment of junior opinion at regular member meetings. It also organizes junior sessions at Regional and National Conventions which afford the junior an opportunity to trade professional experiences with others of his ranking, and helps to stimulate member interest in junior activity.

Last year the Committee created a "Junior Panel" composed of 200 junior members residing in all sections of the country and representing the various age groups. This was a "pilot-plant" operation. Six letters were sent to the panel to acquaint them with the matters under consideration by the National Junior Committee and to provide them with useful background committee information. In May a questionnaire was addressed to the panel asking for opinions on how the National Junior Committee program could be made more useful.

The returns show that the forum is useful to many juniors, especially those in remote areas normally not served by local Section activities. The answers suggested that more round-table-discussion type of meetings dealing with technical problems and work solutions would be helpful. In the Forum columns the juniors asked for more articles on jobs and experiences of other young engineers like themselves. Information on current wage levels, job opportunities, and management attitudes was requested. It was evident from the comments received that ASME juniors feel the Society can best aid them by providing the means by which they can work to shorten the period of transition between the student and the practicing engineer.

### Four Conferences Annually

Second only to the Forum in benefits to juniors is the National Junior Committee's project, now entering its third year, of sponsoring conferences at national meetings at which men of attainment meet informally with young men for an exchange of views of matters of professional development. Ten to twenty juniors whose expenses are partially defrayed by the Old Guard, participate in these events. A report on the junior conference held during the Semi-Annual Meeting was published on page 774 of the September issue. As part of the same project, eight other juniors representing Sections in Region VI attended the Fall Meeting in Minneapolis, Minn. They participated in a conference at which Fred T. Agathe, Allis-Chalmers Manufacturing Company, Milwaukee, Wis., was the principal speaker.

The Committee feels that its own particular field of service is that of attracting student mechanical engineers to transfer upon graduation to the junior member grade. Juniors of the Philadelphia Section have developed a program which regularly achieves a high percentage of student transfers. The general utilization of this procedure in other sections is one of the objectives of the National Junior Committee.

### Forum Objectives

In the following months the Forum will discuss questions raised by junior members. The Forum will continue to carry news of Society activities of interest to Juniors. Articles touching on personal experiences of young engineers will probably cause many members to feel that some of their own experiences are worth writing about. In such a case the Forum shall be glad to print such stories. These should help to expand the scope of these columns.

Elsewhere on this page Robert B. Green, Jun. Mem., from Cambridge, Mass., expresses himself on the type of meeting from which young engineers can benefit most. Juniors who have suggestions on how the ASME can improve its service to members should submit these suggestions in writing to the Society. In the Forum they will receive a nationwide hearing and may be judged and tried in various Regions of the Society.

## The Best Type of Meeting for Junior Members

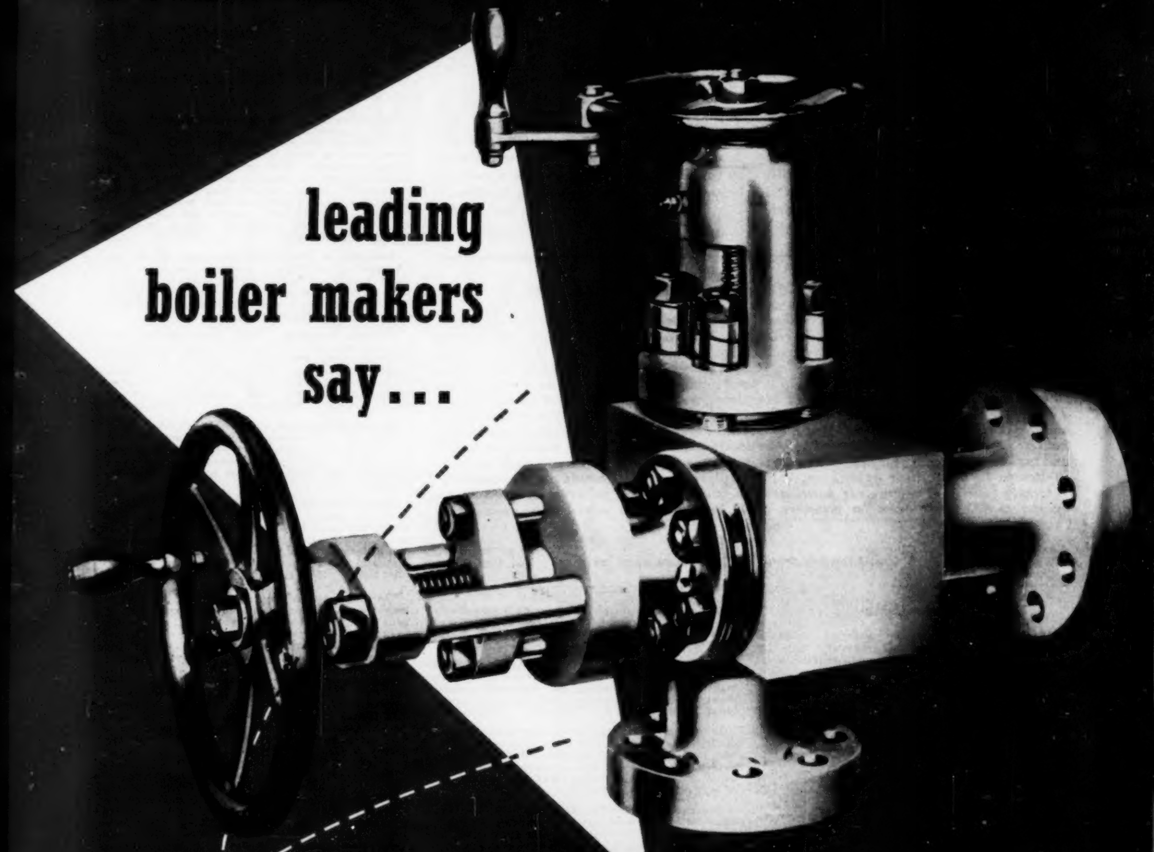
THE American Society of Mechanical Engineers can be a big help to its junior members by arranging regular local meetings at which groups of juniors can discuss current problems they are facing in their work. These meetings should be informal, in the spirit of interesting dinner-table conversations often heard prior to formal ASME meetings. Such meetings can be built around a panel of five or six men, either all from the same organization, or from several organizations, but all working on similar problems. In addition to informality, such meetings should have two other characteristics. These are: First, that young men do the talking from their own point of view, rather than from that of senior workers and supervisors; and second, that discussions center about current difficulties in a field, difficulties which are at most only partially solved, rather than presentations of completed solutions to problems.

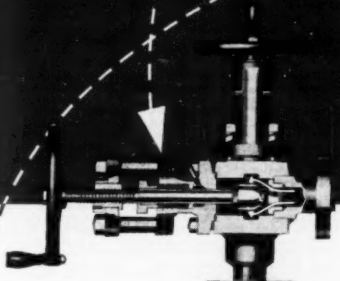
Young engineers can gain much by comparing notes with their colleagues and contemporaries, and they usually have considerable fun doing so. It helps a lot to see in some detail how others go about meeting their problems, particularly since the solved problems usually presented at formal meetings are given with little emphasis on the many day-to-day difficulties which had to be overcome before the final simple methods of solution were obtained and used. The difference is considerable between a presentation of a successfully completed project and a discussion of attempts at solution of difficulties in work in progress. Vicarious experience gained through such discussions adds to a man's own experience and hastens his professional growth.

One important by-product of meetings such as these is that the young men who participate in them learn to know one another, to feel more "esprit de corps" as engineers, and to become more aware of the opportunities and advantages of ASME membership. The meetings should attract many members who do not now come to meetings.

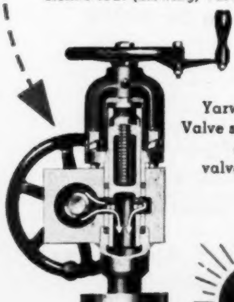
It may be that some corporations will hesitate in permitting their engineers to participate in such open discussions of unsolved company problems, but there should be more than enough areas of discussion not so re-

(*ASME News continued on page 870*)



Yarway Unit Tandem Valve sectioned through stellite-seat (blowing) valve. Open position.



Yarway Unit Tandem Valve sectioned through seatless (sealing) valve. Open position.

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stricted. It should be noted that there has been a shift of policies in recent years regarding "trade secrets" which has permitted the publication of many papers in the ASME journals which formerly would have been kept within the organizations represented. The advantages of free interchange of ideas and methods among engineers outweigh the disadvantages of revealing some information to competitors, and this fact now appears to be recognized by most engineering concerns.

ROBERT B. GREEN, Jun. ASME.

## Engineering Societies Personnel Service, Inc.

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### Men Available[1]

**Mechanical Engineer,** 29, married, BSME, Lehigh; MME, Cornell. Registered. Experience: two years thermodynamics instructor, $3^1/_2$ years research and development fluid and applied mechanics. Desires automatic or rotary machinery development. Prefers East. Me-849.

**Mechanical Engineer,** 45, married, with diversified experience in building maintenance, supervision of maintenance, operation, specification, purchase, and installation of metallurgical and industrial furnaces, air conditioning, and related mechanical and electrical equipment and controls. Me-850-518-D-2.

**Plant Engineer** with five years' diversified experience including power-plant, maintenance, and industrial instruments. Aggressive young mechanical engineer, excellent for small plant. Tau Beta Pi. Married. Prefers Midwest. Me-851-155-C.

**Junior Industrial Engineer,** 28, single, veteran, BSADE. Certified EIT, aggressive, and desires opportunity. Experience: $1^1/_2$ years standard cost procedure, time study, setting standards, and standard data. Some methods and plant layout. Me-852.

### Positions Available

**Assistant Editor,** preferably graduate mechanical or industrial engineer, either recent graduate or with one or two years' experience. Must have an interest in writing; background in materials handling desirable, but not necessary. Excellent opportunity with a fast growing magazine in the field of industrial engineering. To $4800. New England. Y-5814.

**Design Engineer,** training and experience, to design, prepare layouts, and write specifications for heating, ventilating, and air-conditioning systems for buildings, including churches, schools, commercial and industrial buildings. About $7200. Va. Y-5885.

**Mechanical Engineer,** over 35, mechanical degree, to investigate plant-operating problems. Will design installations involving dust and fume control; pumping systems for process installations, heat exchangers, condensers, and crystallization equipment. Knowledge of mechanical materials-handling equipment such as elevators, conveyers, etc. Should have had experience with chemical company or allied industry. $5040–$8000. N. J. Y-5887(*a*).

**Mechanical or Mining Engineer,** coal production and preparation experience, to supervise installation, operation, and maintenance of coal-preparation plant. $12,000. Duration two years. Turkey. Y-5891.

**Project Engineer,** 28–38, mechanical graduate, at least five years' machinery and equipment design, specification, purchasing and application experience, to co-ordinate engineering subcontracting and outside production. Must be citizen; clearance desirable. $10,000. New York, N. Y. Y-5894.

**Plant Engineer,** 40–50, mechanical or chemical graduate, at least 15 years' process and equipment maintenance experience, to supervise power plant, chemical processing, and ordnance equipment. $8400–$10,200. Midwest. Y-5905.

**Industrial Engineer,** 30–40, mechanical or industrial graduate, at least four years office methods, time study, planning, cost reduction in merchandising or allied fields, to analyze store operations and perform general staff duties. $7500. New York, N. Y. Y-5920.

**Application-Research Manager,** 35–45, mechanical or electrical graduate, at least ten years' design, product development, and application experience covering power-transmission machinery, to analyze market potentials, contact power-equipment manufacturers, assist on sales-promotion work in centrifugal-clutch field. $10,000–$12,000. Midwest. Y-5926.

**Research Assistant or Associate Professor,** PhD in mechanics, to teach advanced fluid mechanics, tensor analysis, and carry on research in experiment station. Up to $4800. Starting date September or January. Middle Atlantic States. Y-5929.

**Mechanical Engineer,** graduate, 30–40, at least five years' design and development of special mechanical equipment, to supervise mechanical-process development laboratory, engineering staff, and small versatile machine shop. Experience desirable in plastics industry utilizing hydraulic equipment and electronic control systems. $8000–$10,000. Mass. Y-5933.

**Staff Engineer,** 35–45, at least five years' methods, general manufacturing, and cost-accounting experience, to survey plant production facilities, covering tools, dies, stampings, machining, and assembly operations. $10,000–$15,000. Headquarters, Mich. Y-5947.

**Industrial Engineer,** mechanical graduate, not over 55, considerable production experience, some of which should have been in fire control. Good background in shop, process engineering, or tool design desirable. Will call on contractors and subcontractors to expedite production controls, co-ordinate design and development, improve production-control methods, and materials control, etc. Inspect pilot models and pilot runs, etc. Considerable traveling. $6400, plus expenses. Headquarters, Pa. Y-5966.

**Assistant to Production Manager,** 30–40, industrial or mechanical graduate, at least five years' experience in electromechanical instrument field covering machine-shop production, scheduling, quality control, etc. Must be U. S. citizen. $5000–$7000. Brooklyn, N. Y. Y-5978.

**Process Engineer,** 35–45, industrial or mechanical graduate, at least five years' supervisory methods and processing experience in instrument- or electronic-control fields, to co-ordinate design, development, and production of electromechanical devices and electronic controls. $8000–$10,000. Western N. Y. Y-5979(*a*).

**Industrial Engineer,** 40–45, 15 years' fabrication, production, time-study, and wage-incentive experience in heavy machinery fields and job shops, to analyze operations, improve manufacturing methods, and wage-incentive system. $10,000–$12,000. Del. Y-5982.

**Superintendent,** 35–45, mechanical graduate, at least five years' supervisory machine-shop and machinery-manufacturing experience in textile or allied fields, to take charge of shop production, including welding of machinery frames, assembly, test, and shipment of special machinery. $15,000 plus bonus. New England. Y-5990.

**Development Engineer,** mechanical, up to 35, at least three years' experience in electrical-rotating-type equipment from the mechanical viewpoint. Will work on service, development, design, research, and production problems on motors and generators. $6000. Ill. R-8075.

**Designer-Estimator,** mechanical engineer, 28–50, two years' experience designing pressure vessels to ASME Code. Knowledge of design and estimating. Will design, estimate, and have partial supervision of sheet-metal fabrication of pressure vessels. Company will help on fee. $5000–$7500. Ill. R-8114(*a*).

**Engineers.** (*a*) Chief engineer, knowledge of cupmaking machinery. Will design special machinery for manufacture of paper cups exclusively. Company will help on fee and moving expenses. Will be in complete charge of engineering. $15,000–$25,000. Southern Calif. (*b*) Project engineer, knowledge of paper-converting machinery. Will build special paper-coverting machinery from blueprints or partially completed models. May have to redesign some types of machines. Company will help on fee. $7000–$10,000. Chicago, Ill. R-8115.

**Works Manager,** mechanical engineer, up to 50, record of successful management of production in multiple-plant metal-fabrication company. Knowledge of modern factory practices, tooling and metalworking equipment. Supervise multiple-plant operations in metal-fabricating and coving producting, maintenance, purchasing, inspection, methods, production control, and labor relations. Company may help on fee. $12,000–$18,000. Ill. R-8121.

**Manager of Manufacturing,** up to 45, engineering degree, experienced in management of production-line and job-shop operations in plants of 1000 employees in heavy equipment. Knowledge of forgings, castings, structural shapes, bar plate, and purchased components. Will supervise over-all functions with respect to inspection, production control, tooling, methods, and time standards. $15,000–$18,000. Ill. R-8125.

[1] All men listed hold some form of ASME membership.

## Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after Oct. 25, 1951, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

### KEY TO ABBREVIATIONS

R = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

### NEW APPLICATIONS

*For Member, Associate, or Junior*

ALBRECHT, ADOLPH J., Palisades Park, N. J.
ALLEN, STANTON, Milwaukee, Wis.
AMELUNXEN, JOHAN F., Caracas, Venezuela, S. A.
ANDERSON, ALLAN G., West Hartford, Conn.
BAIRD, E. DOUGLAS, Berkeley, Calif.
BELL, JAMES M., Buffalo, N. Y.
BLACK, GERALD L., Dearborn, Mich.
BROWN, JAMES P., Philadelphia, Pa., (Rt & T)
BROWNING, DELMER M., Phoenix, Ariz.

(*ASME News continued on page 872*)

Chamberlin, Ellis F., Palos Verdes Estates, Calif.
Cherback, Milton P., New York, N. Y.
Collison, Malcolm N., Flin Flon, Man., Can.
Day, Charles E., Wilmington, Del.
Durham, Raymond E., Jr., New York, N. Y.
Eglinton, George F., Lincoln Park, Mich.
Ferguson, Oscar, Jr., Port Norris, N. J.
Forsyth, John G. M., Melvindale, Mich.
Green, Willard E., Michigan City, Ind.
Gregory, J. H., Kitchener, Ont., Can.
Henderson, Robert F., New York, N. Y.
Henry, William R., Huntsville, Ala.
Hicks, Tyler G., Hicksville, N. Y.
Hobson, Percy, Jr., Montreal, Que., Can.
Horvath, Robert J., Portland, Ore.
Jackson, Robert L., Altamont, N. Y.
James, Chester K., Cleveland, Ohio
Janak, John J., Jr., Dallas, Texas
Jasany, Frank A., Wickliffe, Ohio
Jolley, R. S., Wisconsin Rapids, Wis.
Karmann, A. R., Tulsa, Okla.
Kass, Robert A., Fond Du Lac, Wis.
Liverant, Manfred J., Prescott, Ont., Can.
Luley, Wilbert E., Oakmont, Pa.
Maier, Alan R., Mountain Lakes, N. J.
Marvin, C. W., Shreveport, La.
Mather, R. L., Peterborough, Northamptonshire, England
Melzer, John F., Cincinnati, Ohio
Meyer, James A., Newton, Iowa
Moore, W. R., Jr., Hagerstown, Md. (Rt & T)
Nelsen, John T., Brooklyn, N. Y.
Nipken, Walter, Hartford, Conn.
Peterson, Donald E., Homewood, Ill.
Ralston, Louis T. M., Philadelphia, Pa.
Reed, Donald F., Chicago, Ill.
Rinehart, J. A., Kalamazoo, Mich.
Robbins, Irving M., Brooklyn, N. Y.
Rotsko, Alexander, Somerset, Mass.
Sanham, Arthur H., Singapore, Malaya
Schell, Albert J., Bowmansville, N. Y.
Schisselbauer, Robert T., Greenville, S. C.
Shahani, B. T., Cossipore, Calcutta, India
Stearns, Walter V., White Plains, N. Y.
Steketee, Frank W., E. Grand Rapids, Mich.
Stiffes, Marvin C., St. Louis, Mo.
Strudevant, Bruce L., Muscatine, Iowa
Tobe, John, Miami, Fla.
Turner, Henry D., New Orleans, La.
Vetere, Anthony M., Upper Darby, Pa.
Wanosness, M. W., Chicago, Ill.
Ward, Darrell E., Baton Rouge, La.
Warney, Robert F., Rochester, N. Y.
Zivi, Samuel M., Clayton, Mo.

CHANGE IN GRADING

*Transfers to Member and Associate*

Balter, Harvey M., Newark, N. J.
Belanger, Lucien, Outremont, Que., Can.
Danielson, Albert L., Denver, Colo.
Dorsey, Joseph W., Pleasant Hills, Pittsburgh, Pa.
Elrod, J. T., Houston, Texas
Fulton, Marvin O., Harvey, Ill.
Gilbert, Carl L., Albuquerque, N. Mex.
Kiplinger, C. Gale, Snyder, N. Y.
Larinoff, Michael W., Brooklyn, N. Y.
Leunis, Robert R., Towanda, Pa.
Maxwell, Harold I., Newport News, Va.
Meerbaum, Sam, Union City, N. J.
Olivetti, Adriano, Ivrea, Torino, Italy
Pinnes, Robert W., Alexandria, Va.
Popa, George, Chicago, Ill.
Scheer, Lloyd F., Alexandria, Va.
Shackelford, D. M., (Mrs.), Brooklyn, N. Y.
Wagner, H. C., Sea Cliff, N. Y.
Werner, H. Blake, Aberdeen, Md.

*Transfers from Student Member to Junior . . .* 100

## Obituaries

**Boris Alexander Bakhmeteff (1880–1951)**

Boris A. Bakhmeteff, honorary professor of civil engineering, Columbia University; consultant on hydraulic problems, and executive officer of several companies, died July 21, 1951, at his summer home in Brookfield, Conn. Born, Tiflis, Caucasus, Russia, May 14, 1880. Parents, Paul and Julia (Novitsky) Bakhmeteff. Education, graduate, Classical Gymnasium, Tiflis, 1898; CE, Institute of Engineers of Ways of Communication, St. Petersburg, 1903; studied at Polytechnic Institute, Zürich, 1903–1904; DE, Polytechnic Institute, St. Petersburg, 1911. Married Helen Speransky, 1905 (died 1921); married 2nd, Marie M. Cole, 1938. Naturalized U. S. citizen, 1935. Dr. Bakhmeteff was sent to the United States in 1915 as a member of the Russian government's central war industries purchasing committee. After the fall of the Czarist regime in 1917, he became Secretary of State under Alexander Kerensky, president of the provisional Russian government, and later Ambassador to the United States, a post he held until 1922. He received the Laurie Prize, 1937; J. C. Stevens Award, 1944; co-winner, Norman Medal, 1947, all from ASCE. His books include: "Lectures on Hydraulics" (1912), "Varied Flow of Liquids" (1914), "Hydraulics of Open Channels" (1932), and "Mechanics of Turbulence" (1936). The latter work won for him, in 1946, the Grande Medaille de l'Association des Docteurs Ingenieurs de France. For his outstanding contributions in the field of hydraulics, the French government awarded him the academic degree of Officer of the Academy and Public Instruction, 1947. Mem. ASME, 1931; Hon. Mem. ASME, 1946. He was an honorary member of ASCE. Survived by wife, a sister, and a step daughter, Carol Herrera.

**Francis Joseph Behr (1874–1951)**

Francis J. Behr, Col., U. S. A., retired, died March 4, 1951. Born, near Strassburg, Germany, Jan. 13, 1874. Education, St. Vincent College, Pa., 1890–1898; Coast Artillery School, 1906. Mem. ASME, 1914. Survived by wife.

**Russell Todd Fisher (1892–1951)**

Russell T. Fisher, president and secretary, National Association of Cotton Manufacturers, Boston, Mass., died April 24, 1951. Born, Gloucester, Mass., July 3, 1892. Parents, William F. and Anne (Todd) Fisher. Education, attended Worcester Polytechnic Institute; BTE, Lowell Textile Institute, 1925. Married Patricia Webb, 1920; children, Anne Wilmouth, Patricia Webb, Willa Todd. Assoc. Mem. ASME, 1923; Mem. ASME, 1935.

**Emilio Paul Gibillini (1920–1951)**

Emilio P. Gibillini, mechanical engineer, Pelton Water Wheel Co., San Francisco, Calif., died April 18, 1951. Born, San Francisco, Calif., Aug. 25, 1920. Parents, Enrico and Maria (Tollini) Gibillini. Education, BSME, University of California, 1944. Jun. ASME, 1945. Survived by parents and a sister, Angelini A. Fioretti.

**Harry Vercoe Haight (1873–1951)**

Harry V. Haight, retired chief engineer, Canadian Ingersoll-Rand Co., Ltd., died July 3, 1951, at Sherbrooke, Que., Can. Born, Sparta, Ont., Can., July 16, 1873. Parents, Edward and Margaret (Vercoe) Haight. Education, BASc, Toronto University, 1897. Married Maude Watt, 1901 (died 1905). Jun. ASME, 1899; Mem. ASME, 1907. Survived by three children, Margaret M., Sherbrooke, Que., Can.; Constance V., New York, N. Y.; Russell W., California; and a sister, Elizabeth G. Haight, Sherbrooke.

**Robert Mawson (1878–1951)**

Robert Mawson, retired industrial engineer, Providence, R. I., died on July 7, 1951. Born, Bradford, Yorkshire, England, July 19, 1878. Parents, Charles and Jane (Lamb) Mawson. Education, mechanical-engineering course, Bradford College, 1895. Naturalized U. S. citizen, Providence, R. I., 1919. Married Annie Lightowher, 1903. Mem. ASME, 1913. Survived by wife and two children, Beatrice Gould, Providence, R. I., and Leslie C., South Bend, Ind.; and two grandchildren.

**Stanislav Albert Sulentic (1880–1951)**

S. A. Sulentic, consulting engineer, Topeka, Kan., died in O'Neill, Neb., July 18, 1951, of a heart attack. Born, Dvor, Jugoslavia, May 5, 1880. Son of Mr. and Mrs. Albert Sulentic. Education, graduate, School of Engineering, Karlsruhe, Germany, degree in mechanical and electrical engineering. Naturalized U. S. citizen, 1905. Married Freda Isabel Neske, 1925. Mem. ASME, 1942. Survived by wife.

**Harry Foraqua Thompson (1891–1951)**

Harry F. Thompson, boiler and machinery inspector for several insurance companies in Arizona, died in Phoenix, Ariz., June 21, 1951. Born, Birmingham, Ala., May 29, 1891. Parents, William and Alice (Abernathy) Thompson. Education, correspondence course, college of engineering, Lexington, Ky. Married Mary Curtis, 1929. Assoc. ASME, 1950. Survived by wife.

* * *

Correction: In the September, 1951, issue of Mechanical Engineering the death of Edward Leyburn Moreland is listed as July 17, 1951. The correct date is June 17, 1951.

## ASME Master-File Information

*(Not for use of student members)*

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## Keep Your ASME Records Up to Date

HEADQUARTERS depends on its master membership file for answers to hundreds of inquiries daily pertaining to its members. All other Society records and files are kept up to date through changes processed through it. The listings in future ASME Membership Lists will be taken directly from the master file. It is important to you that it lists your latest mailing address and your current business connection.

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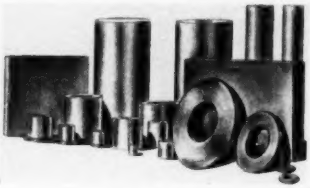
## • NEW EQUIPMENT

### Bronze Bearings

Boston Gear Works announces a large number of additional sizes of Bost-Bronz oil-impregnated porous bronze bearings to meet the popular demand for a comprehensive range of stock sizes in cylindrical bearings, flange bearings, thrust bearings, cored bar, solid bar, and plate stock.

Bost-Bronz bearings are interchangeable with solid bronze bearings. Having an oil film to start on as well as to run on they operate quietly and give long service. There is no oil drip or waste and there are no openings for grit, lint, or dirt. Oil holes or grooves are eliminated and with them the expense of machining. The complete range of sizes permits simple press fits.



Of particular significance to users of bearings is the ready availability of Bost-Bronz bearings from near-by stock. There are 85 authorized distributors carrying stocks of the various types and sizes.

The latest edition of the Boston Gear Works Catalog No. 55 contains complete information on Bost-Bronz bearing stock sizes, prices, tolerances, and load ratings. Copy of the Catalog may be obtained from any of the 85 distributors or from Boston Gear Works, 66 Hayward St., Quincy 71, Mass.

### Variac Speed Control

A new Type 1700-B variac speed control, announced by General Radio Co., Cambridge, Mass., offers several new features for $^1/_3$-hp motor control, the most important of which are instant starting and freedom from tube replacement. These features are made possible by the use of selenium rectifiers in place of the rectifier tube used in the earlier model. Life tests on these new rectifiers indicate almost indefinite life expectancy for ordinary applications as they are used in the Type 1700-B control.

The new control has the field supply isolated from the armature circuit by a transformer. This means that standard compound-wound motors having five leads can be reversed by means of the switch on the control. Strong dynamic braking is obtained in the stop position, although the motor can be stopped without dynamic braking if the a-c input switch is used. In either case starting is instantaneous and the short-period overload capacity is very large so heavy loads can be started quickly. A time-delay magnetic circuit breaker protects the control and motor in the event of a stall.

Speed can be controlled from rated motor speed down to zero. The rpm rise in speed between full load and no load is roughly the same at all speeds and is about 400 rpm. The very low ripple in the armature circuit means that there are no torque pulsations and standard motors can be used at their full ratings.

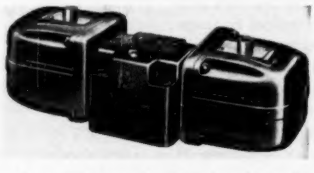
### Clay Pelletizer

An extruding machine, designed especially for pelletizing clay, is now being built by Farrel-Birmingham Co., Inc., Ansonia, Conn. The pellets made by this 6-in. extruder are used in the production of high-octane gasoline and other petroleum products.

Essentially, the machine consists of a specially designed screw contained in a steel cylinder. The screw is bored for coolant circulation, and the cylinder, which is lined and jacketed, has a hinged head at the discharge end which supports the pelletizing die and cut-off mechanism. The drive is by electric motor through a Farrel double-reduction gear drive, and the arrangement of the entire assembly is compact and convenient for operation and maintenance.

### Hydraulic Valve

To overcome the problem of spool-sticking common to 4-way solenoid valves in high-pressure hydraulic circuits used for long cycling operations, The Denison Engineering Co., Columbus, Ohio, has developed a pilot-operated valve that utilizes system pressures to move the spool. Solenoids are used only to operate small internal pilot valves.



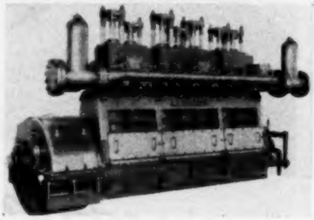
As a result, spool action is said to be smooth, quick, and positive under all operative conditions to 5000 psi. The valve is also designed so that the spool always moves at the same rate of speed regardless of operating pressures.

The valve is available in $^3/_4$ and $1^1/_2$-in. sizes, in both single and double-solenoid types, with provision for either external or internal pilot connections.

Eight types of spools provide for eight different porting combinations. In the double-solenoid unit, the spool is automatically pressure-centered when the solenoids are de-energized.

### Direct Flow Pumps

The Aldrich Pump Co., Allentown, Pa., announces the addition of a 6-in-stroke direct-flow pump series to their over-all line. This series includes Triplex, Quintuplex, Septuplex, and Nonuplex units, having 3, 5, 7, and 9 plungers, respectively. Ranging from 300 to 900 hp, the 6-in-stroke series covers numerous applications, such as chemical handling, heavy forging press service, steel-mill descaling, water injection in oil fields, lean oil pumping, etc.



These Aldrich direct-flow pumps operate at crankshaft speeds up to 300 rpm and are suitable for direct drive by engine or synchronous engine-type motor. The pumps feature inverted design and a direct-flow fluid-end. All wearing parts are interchangeable among 3, 5, 7, and 9-plunger units. The fluid-end is sectionalized in construction so that maintenance is simplified and inexpensive. Reduced space between valves affords higher volumetric efficiency; and changes in plunger size can be readily made to meet alterations in pressure or capacity.

For complete information, request Data Sheet 67-A from the Aldrich Pump Co., Allentown, Pa.

### Stoker Efficiency

Material increase in the over-all combustion efficiency of its industrial stokers is claimed by the Iron Fireman Mfg. Co., Cleveland, Ohio, through development of automatic linkage of the fuel and air supply which keeps the air-fuel ratio in continuous balance.

Accurate metering of coal from bunker to boiler by means of the worm conveyer is synchronized with the accurate metering of air from fan to boiler by the Iron Fireman Air Volumeter. Thus the correct air-fuel ratio is maintained regardless of varying load demands. The unit can be adjusted for any speed between maximum and minimum and is not restricted to 3 or 4 predetermined speeds.

Operating rate of the stoker is determined by the position of the upper quadrant in the control panel. This may be connected directly to the power operator of a modulating combustion control or operated manually as well. Iron Fireman says the control can be set for quick build-up of fire after cleaning.

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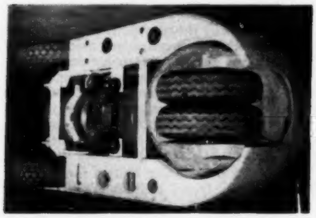
When changes in the air-fuel ratio are required due to changes in heating value or other characteristics of the coal used manual adjustment of the "air ratio" quadrant is all that is required.

### Lift Truck Wheel Design

Easier, almost effortless steering, further reducing operator fatigue with resultant increase in materials handling, has been made possible by an improved wheel design on the Model YT-40 (4000-lb-capacity) fork lift truck manufactured by the Hyster Co., Portland, Oreg.

All model YT-40 lift trucks now are being equipped with dual wheels instead of a single wheel on the steering trunnion. Present single-wheel type Model 40s can be converted if desired, to dual wheels with a minimum of alteration. The removal of one easily accessible lock stud permits rapid and convenient tire service and maintenance.



The new design also has reduced the gear ratio in the steering mechanism from 31 to 1, to 20.7 to 1, requiring only seven turns of the steering wheel instead of 10.3 formerly to swing the trunnion 120 deg. Even when the truck is stationary, the trunnion can be turned with a minimum of effort.

The Model 40 industrial-type pneumatic tire size has been reduced to 6.00 × 9 to provide interchange with tires on the Hyster Model 20 (2000 lb-capacity) lift truck.

### Spring-Retainer Ball Bearihg

One of the keys to miniaturization is the new spring-retainer Micro ball bearing, in production at New Hampshire Ball Bearings, Inc., Peterborough, N. H.

Formerly obtainable only in larger sizes, this new bearing measures $^3/_{32}$ in. bore × $^5/_{16}$ in. OD × $^7/_{64}$ in. wide, in tolerances ABEC 5 and higher. Characteristic of the type are low and uniform values of starting or breakaway torque, a high percentage falling in the range 0.0006 in-oz under a standardized 75 grams thrust load. Individual stainless-steel coil springs serve as separators. Rings and balls are standard in high-carbon chrome steel (Cat. #R1-5A1) as well as stainless AISI440 (#SR1-5A1).

Catalog on request to New Hampshire Ball Bearings, Inc. (Key Address) Peterborough, N. H.

### Low-Temperature Unit Coolers

Seven models of low temperature unit coolers using ammonia refrigerant and seven similar models using Freon have been placed into production by York Corp., York, Pa.

These new units are for applications requiring below-freezing temperatures, such as frozen-food storages, fur storages, meat-packing plants, ice-cream plants, etc.

The units are compact and provide rapid defrosting by water spray. Unit coolers may be used in multiple where greater capacity is required.

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### Special Conveyer System

An ingenious new conveyer system is speeding defense production at Eastman Kodak Company's Camera Works, in Rochester, N. Y.

Combining elevator belt, horizontal belt, and link chain conveyers to move parts from the automatic screw machines to the final inspection bench, the new system cuts total handling time by almost half.

Briefly, the system works as follows:

Four screw machines are employed on the project. A bucket attached to the slotting arm on each machine catches the part as it is severed from the bar and transfers it to a chute. Here the part slides by gravity to a point where it is picked up by a cleat on a Plexiglas-enclosed elevating belt.

At the top of the rise a stationary cam deflects the part into another chute. It drops by gravity through a 90-deg twist and is deposited flatly on an 8-in. belt which runs above the four machines served.

A tripping device at the end of the horizontal belt deposits the parts, one at a time, into swinging wire receptacles mounted on each side of a link chain. A sprocket drive moves the chain through a degreaser and then to the inspection bench. There finished parts are removed from the receptacles by hand, inspected, and stacked in trays for shipment.

### Starting Motors

Two new air starting motors for cranking gasoline and Diesel engines are announced by Ingersoll-Rand Co., New York, N. Y., for use in the lumbering, petroleum, mining, marine, heavy construction, and power fields. They are designed for cranking Diesel and gasoline engines with piston displacements up to more than 3500 cu in. Although normally operated by compressed air, they are also suitable for operation on natural gas where available at sufficient pressure.

Smaller and more compact than equivalent electric starters, these air starters give reliable starting service at all times. They eliminate the necessity of generators, banks of storage batteries, and the costs of battery maintenance and replacement. They are not affected by climatic conditions, which often injure the insulation of electric motors because of deterioration of windings.

Easily installed, the starters are available in two sizes; the 9BM, which develops up to 16 hp and requires approximately 7 cu ft of air per start; and the 20 BM, which develops up to 41 hp and requires approximately 16 cu ft of air per start. The smaller size weighs 40 lb, and the larger size, 103 lb.

Write Ingersoll-Rand Company, 11 Broadway, New York 4, N. Y., for complete information.

### Self-Reinforced Aircraft Skins

A new machine tool for the manufacture of self-reinforced aircraft skins is being completed by the Giddings & Lewis Machine Tool Co., Fond du Lac, Wis.

Aimed at better adapting aircraft to the demands of near-sonic speeds, the revolutionary, three-dimension milling machine will be pioneered by the Lockheed Aircraft Corp. in the manufacture of F-94 jet fighters.

Details of the complex new tool were designed by the Giddings & Lewis Co. in collaboration with engineers of the General Electric Co. and Lockheed in accordance with basic specifications laid down by the aircraft corporation.

The novel machine will mill integral-rib skin panels from solid or rough-forged aluminum-alloy plate. This manufacture of air-

plane surfaces and their stiffening elements as a unit will permit use of the thinner wings and sharper fuselages required for high-speed jet flying.

Replacing the customary forest of struts, braces, and girders welded or riveted into the plane's structure, the integrally braced surfaces are designed to make the new F-94 planes stronger, faster, and capable of carrying more fire power and greater fuel loads.

This machine, known as the Giddings & Lewis Hypro Aircraft Skin Mill (Type 100) utilizes General Electric motors and control throughout. Operating in three dimensions with two feed motions, it is designed to work in a feed range from $^3/_4$ in. to 150 in. a min with infinite intermediate speeds.

G-E, two-dimension, electronic tracer control is used to guide the longitudinal and lateral cutting motions simultaneously. The skin mill also incorporates a vertical rise-and-fall cutting action to control the variations in web thickness.

### Valve Test Unit

A unique comparison testing machine has been added to a battery of special testing units of the Edward Valve research laboratories of East Chicago, Ind.

The specially designed testing unit physically proves complex factors of low pressure drop and demonstrates the benefits of improved design developments. Fluid gages register the pressure drop of a valve of conventional design and that of an Edward valve of streamlined design with the patented Edward Equalizer.

Half section valves, of the check type design as typically used in 900-lb sp boiler feedwater service, are used in the comparison test. Clear plastic plates cover each valve section so piston travel is visible. Air at a high velocity passes through the valve of conventional design first.

Highlights of the comparison test show the streamlined Edward valve has reduced pressure loss, full lift of the valve piston, and significant reduction in size and weight.

Edward research reports these advantages are primarily due to a new shape, which permits greater and freer flow and minimum turbulence, and the patented Equalizer tube. The Equalizer connects the space over the disk-piston, a relatively high-pressure area, with the lower-pressure area in the valve outlet. Thus, the Equalizer piping relieves the high pressure over the piston.

### Cyclone Furnace Tests

Tests expected to throw more light on the problem of getting better efficiencies from low-grade fuels are being conducted in Barberton, Ohio, in a new installation at the plant of The Babcock & Wilcox Co. The tests are being made by burning the fuels in a cyclone furnace under commercial conditions.

A cyclone furnace is a new device being manufactured by the company which burns crushed coal and other fuels in a whirling tornado of flames within a cylindrical unit producing high temperatures. Fuel and preheated air are introduced cyclonically at one end of the unit and high-temperature gaseous products of combustion are emitted at the other end. Action of the furnace coats the walls of the cyclone with a molten layer of ash into which the fuel is thrown

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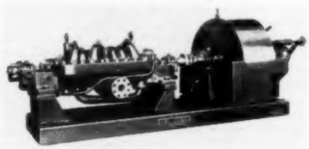
by centrifugal force. Combustible materials burn, giving up heat and noncombustible residue melts and drops into a pit as slag, greatly reducing ash discharge from smoke stacks. A number of these units are in service throughout the nation at the present time.

The cyclone furnace in which the tests are being conducted is a component part of one of the company's new boilers which will be used in regular service at the plant giving operational data under true commercial conditions.

### "Oppeller" Pumps

The new line of multistage opposed impeller pumps as announced by De Laval Steam Turbine Co., Trenton, N. J., are designed for general medium pressure and temperature service up to approximately 1000 gpm and 1200 psi for temperatures to 350–400 F. They are especially well suited to boiler feed service, oil refinery services for handling liquids ranging from propane to strong caustic, and general water services such as descaling, hydraulic, and mine drainage.



The "oppeller" pump has a horizontally split casing with suction and discharge nozzles on opposite sides of the lower half of the casing. Impellers are mounted back to back to balance axial thrust and the volutes are staggered 180 deg to balance radial thrust.

Bolted in stuffing box provides a means of applying a plain box with lantern ring for suction lifts; a water-cooled box for high temperatures and high suction pressures; conventional or special, single or double mechanical seals or a breakdown bushing and leak-off arrangement.

### Ultrasonic Cleaning

Cleaning tiny openings in electric shaver heads, long a major problem in the electric shaver industry because of the tedious and expensive methods used, is now being successfully accomplished by the use of an ultrasonic cleaning device specially designed for this purpose by the General Electric Co., Schenectady, N. Y.

Officials of Schick, Inc., Stamford, Conn., manufacturers of electric shavers, where the experimental cleaning device is in use, report that operating costs have been cut 58 per cent. Also the ultrasonic unit requires only 12 sq ft of floor space, one third of that required by Schick's previous cleaner.

Special compounds used in grinding the parts, as well as metal particles, become lodged in the small corners and capillary spaces of the shaver heads, making cleaning by ordinary methods difficult.

The new method of cleaning simplifies the operation and eliminates brushing of each tiny opening, thus speeding the operation and cutting expense.

The G-E ultrasonic generator, a major component of the new device, converts electric energy into sound energy, at a frequency within the radio-broadcast band. The sound energy is then transmitted through a cleaning solvent through which the

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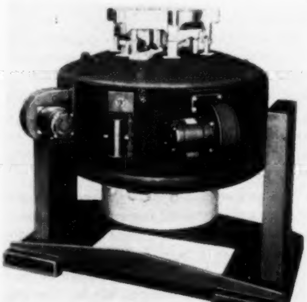
shaver heads, mounted on a moving chain, are conveyed. As the parts pass through the activated field, grease, oil, metal shavings, and lapping compound are removed.

The machine's RF generator supplies high-frequency voltage to a quartz crystal which, vibrating at its resonant frequency, generates sound waves in the liquid (saline solution) in contact with its upper face. These waves then pass through a thin diaphragm into the cleaning solvent where the cleaning action takes place. The sound waves are said to do the most thorough cleaning job of any method yet devised.

The device is easily regulated by simple controls, and is electrically interlocked for safety of operation.

### Vibration Exciter

The MB Mfg. Co., Inc., New Haven, Conn., is in production of its new Model C-25 vibration exciter which has the capacity for meeting specification MIL-E-5272 and 41065B on vibration testing. Such testing is called for on much military equipment since it is said to reveal in advance how products will stand up against vibration in service. It is stated that the shaker develops 2500 lb force and is capable of accelerations 15 times that of gravity under a 100-lb table load.



The shaker features accurate, continuous, easy control of both frequency and force, with electrical interlocks to prevent improper operation of the equipment. Complete shaker weighs approximately 4500 lb and stands almost $3^1/_2$ ft high. The table has a 20-in. diam, and is shielded from a-c or d-c fields. No special mounting foundations are required. The complete equipment consists of exciter, 2-unit rotating power supply, and a control panel which is available with built-in meter to read vibration directly in terms of its acceleration, velocity, and displacement.

### Yarn-Testing Equipment

New equipment to test evenness and to determine the weight of yarn of every known fiber, natural or man-made, has been developed by the research laboratories of Pacific Mills, Lawrence, Mass. The unique equipment uses a special General Electric photoelectric recorder and other electronic devices. Manufactured by the Anderson Machine Shop of Needham Heights, Mass., the Pacific Evenness Tester provides a permanent record of yarn thickness at the rate of 12 yd per min.

Eliminating older trial and error methods, the new tester determines actual fiber weight

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exclusive of moisture and oil content, without previous conditioning in standard atmosphere rooms. The unit was designed to test evenness, and to determine the weight of sliver, roving, and yarn from 4.5 oz per 5 yd wool sliver to 100s worsted yarn, or the equivalent in any other fiber.

The sliver or yarn is fed into the tester through a set of tongue and grooved rolls. The bottom grooved roll is positively driven through a flexible coupling by a 36-rpm gear reduction motor. The top tongued roll is friction driven and is mounted on an arm, pivoted in a casting mounted on the base. The width of the grooves govern the capacity of the tester.

As the sliver or yarn runs between the top and bottom rolls, in the correct groove, variation in thickness causes a linear movement up or down of the top roll. This movement is converted into an electric impulse by a special G-E magnetic displacement gage, which in turn is measured by a micrometer, magnified and inked on graph paper by the special photoelectric recorder.

### Automatic Ring Packing

Johns-Manville of New York, N. Y., has developed a new automatic ring packing called "Uneepac." It is a molded packing and each ring is a complete, self-contained packing unit.

Uneepac is particularly valuable in the design of new equipment and opens the way for many desirable savings. It is designed for maximum sealing efficiency in minimum packing depth so stuffing-box sizes can be reduced. This saves space and cuts machining costs. No follower or header rings are needed. This saves assembly time. Each

ring centers itself perfectly on the preceding ring. This reduces the chance of human error. In service, each lip is always exposed to fluid pressure. This provides instantly responsive, positive sealing and, since Uneepac does not depend on gland pressure for sealing, friction is reduced and there is less wear on both rod and packing.

Uneepac is offered in varied compositions to suit different services—water, steam, oil, air, gas, vacuum, etc. It is furnished in sets of endless or split rings. Uneepac is available for shafts $^{5}/_{8}$ in. in diam and up.

### New Conveyer Chain

A new flat top conveyer which flexes in two planes—both horizontally and vertically—and can curve around corners with a radius of as little as 6 in. with ease, is now being marketed by Chain Belt Co. of Milwaukee, Wis., under the name, Rex FlexTop.

Designed primarily for tip-free conveying of bottles, jars, packages, or small parts, the

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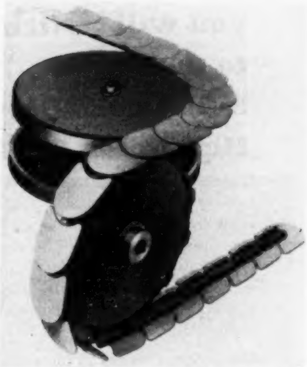
biggest advantage of FlexTop is its elimination of transfer points in the conveyer system. It does away with the danger of containers being chipped, tripped, or otherwise damaged as they transfer from one chain or one conveyer to another. A FlexTop conveyer can be driven from one power source (within limits of chain loading), eliminating the need for transmission parts at transfer points, an added advantage. This can result in considerable savings both in first and operation costs.



FlexTop consists of carbon or stainless-steel crescent-shaped top plates mounted on links which are connected by a specially designed universal joint. Top plates are induction welded to the chain links. The chain operates over special cut-tooth sprockets. It operates around horizontal idler disks, 14 in. in diam at corners. Two disks are used at each corner, one for the carrying strand and one for the returning strand. The speed at which the chain can be run is determined by the product being handled and by the length of the conveyer. For additional information, write Chain Belt Co., Dept. PR, 1600 West Bruce St., Milwaukee 4, Wis., for Bulletin 51-60.

**New Plastics Heating Technique**

In plastics applications it is now possible with a new heating technique to control temperature gradients on calender rolls and press platens to about 1 F, according to the American Hydrotherm Corp. Using water at high pressure or organic liquids at atmospheric pressure as the heat carriers, this accurately controlled heat transfer may be accomplished at temperatures ranging from 250 F to over 1000 F.

For further information, write American Hydrotherm Corp., 33–70 12th St., L.I.C. 6, N. Y.

**Pressure Cells**

Four SR-4 pressure cells in capacities up to 100 psi have been redesigned to make them insensitive to linear acceleration and to position, it is announced by Baldwin-Lima-Hamilton Corp., Philadelphia, Pa. Capacities of these cells, known as Type E, are 10, 20, 50, and 100 psi. Their operation is based on SR-4 resistance wire strain gage measurement with four-arm Wheatstone bridge. Measuring range extends from absolute vacuum to full rated pressure, except in standard units of lowest capacity for which the range is limited to ±10 psi. Pressure cells meeting other requirements are made to order.

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There are two types of cells: Type ES321 cells have all parts in contact with the pressure fluid made of type 321 stainless steel. Type EMB cells have pressure bellows of Monel and brass pressure fittings leading to the bellows. Pressure connections for each are through a standard $^1/_8$-in. male pipe thread.

Type E pressure cells are designed for standard 120-ohm circuit. Recommended input voltage is 5 volts but a maximum of 8 volts may be used. Open-circuit output voltage is 2.000 ± 0.005 mv per volt input to the bridge for capacity pressure. Cells are temperature compensated for zero and span and calibration accuracy is within $^1/_4$% of full scale at any point within rated range. Maximum temperature for full accuracy in continuous operation is 150 F.

### Helical Inserts Salvage Castings

Fuel-pump castings formerly scrapped because of worn and stripped threads are now salvaged with thread inserts made by Heli-Coil Corp., Danbury, Conn., in the re building department of Sid Harvey, Inc., Valley Stream, N. Y. These stainless-steel helical-wire thread inserts provide new threads that are stronger, more wear-resistant, and more corrosion-resistant than the original threads. In addition they are quickly and easily installed.

Between 10 and 20 defective fuel unit castings, or approximately 1% of the units processed by this oil-burner dealer, are repaired by the wire-insert method each week. At a saving of $3 and more per casting, this amounts to a yearly saving of over $2000. Equally important, these thread inserts permit the continued use of castings that might not be replaceable.

Repair operations follow this pattern: (1) The damaged thread is cut out with a drill larger in diameter than the major diameter of the original thread, (2) the hole is rethreaded with a special oversize tap, and (3) a helical-wire thread insert is installed.

### Electronic Scale

The Streeter-Amet Co. of Chicago, Ill., announces the Ametron electronic scale, a new weight determination instrument.

By the use of electronic cells this scale will record and print on ticket, tape, or even a ledger remote from the scale, the exact weight. The load on the electronic scale is measured by Baldwin-Lima-Hamilton Corp. precision load cells. The signal from the load cells, which is proportional to the weight on the scale, is amplified and actuates an error-sensitive servomechanism.

The indicating instrument is a full figure step cam controlled recorder. It includes provision for multiple ranges to give increased capacity with high sensitivity and accuracy.

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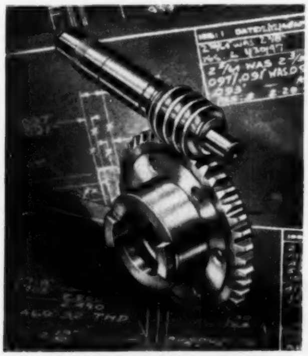
Both the load cells and instruments are designed to operate over wide ranges of temperature. Provision is included in standard recorders to compensate for tare loads.

A brochure explaining the construction, maintenance, and ease of installation of this new scale may be obtained from Streeter-Amet Co., 4101 Ravenswood Ave., Chicago 13, Ill.

### Fractional Horsepower Gearing

Small Gears are made in almost endless variety. Frequently their applications are entirely without precedent. New principles, new design, new engineering . . a different approach to power transmission problems . . all these things and more are often required to produce greater efficiency and economy in small gears. In the new Gear Specialties Inc. 6-page two-color $8^1/_2 \times 11$-in. folder, 15 interesting halftones present a few of the many different types of fractional



horsepower gearing made by G.S., across its 3-page inside spread. Another page features a picture-trip through the modern, daylight G.S. plant. On the back page are two useful standards charts. If you use fractional horsepower gearing from 12 to 96 D.P. on a mass-production basis, this folder will be of considerable interest to you. Write for a copy on your company stationery, addressing: Gear Specialties Inc., 2635 West Medill Ave., Chicago 47, Ill.

### Liquid Rheostats

The world's largest liquid rheostats, to help test full-size jet engines, guided missiles, and wing sections and fuselages of aircraft, will be built by Westinghouse Electric Corp. at its Buffalo, N.Y., plant.

They will be used to regulate the speed of large electric motors at a new wind tunnel at the Arnold Engineering Development Center in Tullahoma, Tenn. The rheostats are part of $20 million worth of electric equipment which Westinghouse is building for the new project.

Each liquid rheostat is more than 20 ft high and consists of three 9-ft-high tanks in which an alkaline solution is circulated. At the bottom of each tank is a stationary nickel-clad steel plate or electrode. A similar electrode is attached to a movable plungerlike support at the top of the tank. Current passes from one electrode to another through the alkaline solution.

As the top electrode plate is lowered, the flow of current is increased, thus speeding up the motor. Pulling the plates farther apart

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cuts down the current flow and the motor speed. The three moving electrodes are hooked up together so the three tanks operate as a single unit.

Two of the motors in this installation will be the most powerful in the world, exceeding the 65,000-hp rating of the Westinghouse motors built for Grand Coulee Dam in the State of Washington.

### High-Pressure Boiler

The largest and highest-pressure boiler in northern Ohio went into operation recently at the Acme Station of the Toledo Edison Co. Designed and built by The Babcock & Wilcox Co., New York, N. Y., it is the latest of 18 existing units at the station and will generate steam to produce 80,000 kw of electricity.

Generating 650,000 lb of steam per hr, the boiler operates at the unusual pressure of 1500 psi.

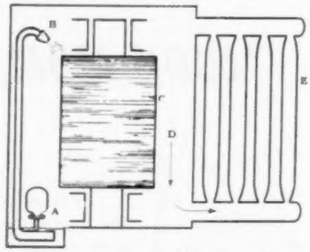
The new boiler supplies steam to a 60 cycle turbogenerator which is replacing a 25-cycle turbogenerator formerly served by 250-lb pressure boilers.

Explaining that more heat means more power, B&W engineers pointed out that steam leaves the boiler proper at 600 F, goes through a superheater in the boiler, and enters the turbine at 1000 F, containing 1490 Btu per lb of steam at the turbine.

The new unit is fueled by pulverized coal down-firing through multitip burners into a divided water-cooled-type furnace. It is expected to consume around 33 tons of coal per hr. It will also burn small quantities of coke-oven gas coming as surplus by-product fuel from a local plant which makes coke for the iron and steel industry.

### Vaporization-Cooled Transformer

A vapor-cooled vapor-insulated transformer that is expected to be $^1/_4$ to $^1/_3$ lighter than liquid-immersed units of equivalent rating and performance is being developed by the Westinghouse Electric Corp., Pittsburgh, Pa. The new cooling technique—a technique that utilizes the heat of vaporization of liquid fluorocarbons for cooling, and the dielectric strength of fluorocarbon vapor for insulating—is a joint development of the Transformer Division and the Research Laboratories.




Two vaporization-cooled transformers have been constructed and operated. The first experimental unit was a modified standard dry-type transformer. Equipped with adequate cooler capacity, the unit delivered in excess of 350 per cent of its rated capacity, dissipating ten times more heat than a dry-type transformer could have. Although at this loading the losses and impedance are much too high for practical operation, the test results do illustrate the possibilities of vaporization cooling.

The second experimental unit, a specially constructed 500-kva, 2400/240-volt transformer, has been operating at rated load since the first of the year. A vaporization-cooled network transformer is being designed for installation on the system of the Consolidated Edison Company of New York. From the operation of this unit will come valuable service experience and the answers to many of the problems that are still not solved.

Vaporization cooling works as follows: A small pump (A) forces liquid fluorocarbon from sump to nozzle (B) where the liquid is sprayed uniformly over the core and coils. The liquid evaporates (C), taking its latent heat of vaporization from the coils. The fluorocarbon vapor fills the space in the tank (D), insulating the transformer parts. The vapor is forced upward through the cooling tubes, and as it condenses the condensate flows by gravity back to the sump. Condensation is accompanied by only a small change in the temperature of the fluorocarbon, which remains near the boiling point throughout the system. The temperature of the cooling surfaces is only a few degrees Centigrade lower than that of the coils, the differential being much less than in conventional liquid-immersed units.

### General-Purpose Pumps

A new line of general-purpose centrifugal pumps has been announced by Economy Pumps, Inc., Division of Hamilton-Thomas Corp., Hamilton, Ohio. Designated as type SCC, the new pumps are light in weight, easy to handle, install, and mount.

Claimed to be an extremely adaptable pump, the new units are well suited for any small pump application such as small cooling towers, domestic water supply, hot water heating systems and lawn sprinkling. They are also well adapted to booster and process pumping, and sewage or stock pump packing gland water supply. They are ideally suited to original equipment installation wherever small pumps are required.

The SCC pumps are of close-coupled type. For long, leakproof operation and to eliminate the necessity of frequent adjusting or gland repacking, they are equipped with mechanical seals. Motors are of the standard open drip type. Standard mounting is vertical; however, with the addition of motor feet, the pumps can readily be adapted for horizontal mounting.

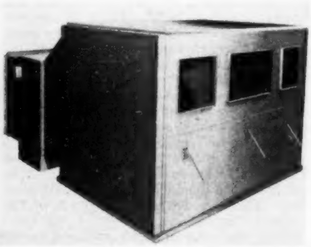
Two sizes are currently available: 2-in. suction × $1^1/_4$-in. discharge and $1^1/_2$ × $^3/_4$ in. Both operate at 3450 rpm. Capacities range to 100 gpm at heads to 120 ft.

Further information is available in Catalog No. D851, available on request to Economy Pumps, Inc.

### Multiple-Zone Air Conditioners

A line of single air-conditioning units to meet year-round comfort needs of up to six different zones in a building has been expanded by The Trane Co., La Crosse, Wis.

This unit, the Trane multiple-zone climate changer, uses but one heating coil and one cooling coil to provide full air-conditioning comfort for as many as six areas. Each zone has its own control, and receives the conditions it needs without affecting any other zone.



The multiple-zone climate changer can eliminate inaccurate air conditioning during the in-between seasons. This is because the unit permits gradual change-over from heating to cooling and back again for each zone. Filters and humidifiers enable the climate changer to do a complete year-round air-conditioning job.

Six sizes of the unit provide capacities as high as 23,400 cfm. Full data on construction, operation, dimensions, and capacities of the Trane multiple-zone climate changer is available in Trane Bulletin DS-303M.

### Rubber to Metal Adhesive

A new chemical development has been made by General Electric's Chemical Department, Pittsfield, Mass., that makes possible a bond between silicone rubber and metals or ceramics that is stronger than the rubber itself.

Designated as G-E 81267 primer, this new development is a thin, light-colored liquid. By using it, G-E silicone rubber 81223 can be bonded to almost any surface. Bonds to glass, ceramics, aluminum, steel, tin, and copper are possible, and sheer strength measurements of bonds on steel are approximately 700 lb per sq in. A unique feature of G-E 81267 primer is its ability, in most cases, to develop a bond strength greater than the strength of the rubber at any stage of the cure.

The technique of applying and using this primer is quite simple and easily fits into the fabricating techniques now employed with the newer G-E silicone rubber compounds. To mold and bond these G-E silicone rubbers to a surface, it is necessary to first remove all grease and dirt from the surface. The primer, G-E 81267, is then applied by dipping and draining, spray, or brushing. The film should then be allowed to air-dry for 20 min. Some surfaces, such as tin, require a short heat-treatment to complete the drying. The surface is then rinsed with water and dried.

The primed surface can now be molded under pressure at 125 C against freshened G-E high-strength silicone rubber compound from 10 to 20 min, or 20 to 25 min in 40 psi steam, and may usually be removed from the mold hot.

### Production-Type Bending Roll

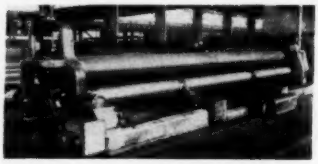
The first "Universal" pyramid-type bending roll designed and built by Baldwin-Lima-Hamilton Corp., Philadelphia, Pa., has been operating several months in a large pipe mill in the south.

Continued on Page 54

## • Keep Informed

The machine was used first to roll $31^1/_2$-ft lengths of 78-in. and 97-in-wide skelp into 24-in. and 30-in-OD tubular shape for high-pressure welded pipe. During the first year of operation, more than 800 miles of this pipe were produced.

Five major design changes were made on the new-type bending roll, principally to increase efficiency for production-line operations. First, all three rolls are driven instead of the two lower rolls only. This avoids drag and, when rolling thin plate, prevents slipping. It also avoids the possibility of stalling under excessive screw-down pressure. Rolls are driven by a 100-hp motor, permitting rolling speeds up to 60 fpm.



Second, a two-speed, differential drive is provided for screw down, thus permitting instantaneous change of speed. High speed up to 30 in. per min is used to position the 20-in-diam top roll; and low speed up to 12 in. per min is for applying increasing bending pressures. Maximum clearance between rolls is 6 in. Screw down is driven by a 100-hp motor.

Third, the distance between the bottom roll centers can be varied from 18 to 24 in. by a motor drive. As the bottom roll centers are adjusted outward, the top roll loading decreases for a given plate. Thus, the top roll deflection can be controlled to present a comparatively straight roll surface to the plate. This avoids the "barrel effect" on the cylinder. The motor-driven roll adjustment is much simpler than shimming the roll stands and housings, or using strips to offset top roll deflection. This bending roll may be used on plates up to $^7/_8$ in. thick.

Fourth, accessibility at the drop end of the bending roll is improved by locating the drop end hydraulic cylinder in a horizontal position. This also decreases the depth of the pit under the machine.

Fifth, the gears are fully enclosed in oil-tight cases. This minimizes wear and protects the gears from scale or grit.

### 185,000-Kw Steam Turbine

The Steam Division of the Westinghouse Electric Corp., South Philadelphia, Pa., has received an order from the Public Service Electric and Gas Company of New Jersey for a 185,000-kw tandem compound steam turbine, largest single-shaft 3600-rpm turbine ever to be built. The unit will be designed with 25-in. blades, longest ever used, and will be installed at the Burlington, N. J., plant.

The turbine will operate with steam at an initial pressure of 2350 psi and at 1100 F, with reheat to 1050 F, and will be a triple exhaust unit.

Tips of the 25-in. blades will travel at approximately 1070 mph when the turbine is in operation. The unit is scheduled for shipment early in 1954.

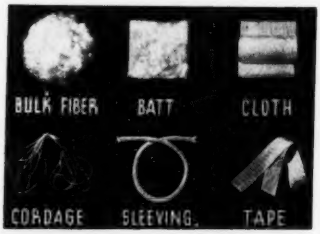
### High-Temperature Insulation

A fibrous silica insulation originally developed in batt form under rigid Air Force requirements for installation in jet aircraft is now proving to have revolutionary adaptability for use in all types of industry.

The insulation, Refrasil, was first developed by The H. I. Thompson Co., Los

## • Keep Informed

Angeles, Calif., in answer to an Air Force need for a lightweight, removable insulation blanket. Its purpose is to protect personnel and the structure of jet-propelled aircraft against temperatures higher than any previously encountered in aircraft operation. The H. I. Thompson Company solved the problem by producing a removable blanket able to effectively provide maximum insulation up to 1800 F with less than one half the weight and bulk of comparable materials.



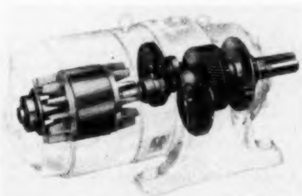

Today, the revolutionary versatility of Refrasil is being demonstrated in an ever-widening field of industry by application to thermal and electrical insulation problems in petroleum, chemistry, electronics, to name only a few.

A typical new use of Refrasil material is that of sleeving as electric space separators in thermocouple leads. This sleeving may be applied with maximum effectiveness where temperatures up to 1800 F are encountered. Its lightweight and minimum bulk, as well as its unusual flexibility, makes it particularly desirable for a specific insulation problem.

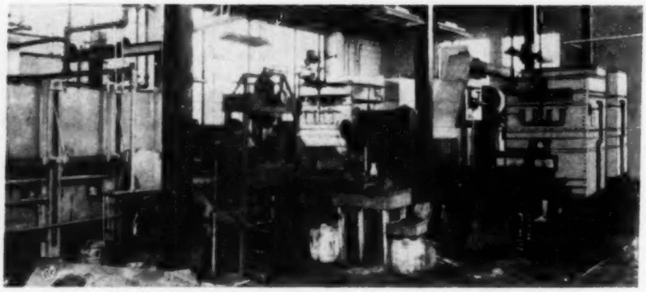
The essential physical properties of Refrasil are chemical resistance of pure silica and high-temperature resistance. Refrasil batt has low thermal conductivity, effective acoustical insulation, fiber diameter of 0.00020–0.00040 in., specific heat of 0.19, nominal thickness of $^{3}/_{16}$ in., and surface density of 0.05 lb per sq ft (less than one half of comparable materials).

### Twin Pinion Syncrogear Motor

A new principle in geared motors has been developed by U. S. Electrical Motors of Los Angeles, Calif., in their type GL Syncrogear. By using two secondary pinions to drive the output gear, U. S. engineers have doubled the effective torque rating of a conventional single-pinion and gear unit. Incorporating the use of a splined herringbone pinion to equally divide the load between the two secondary pinions, the type GL Syncrogear produces high torque at low speeds while occupying only a fraction of space required of a conventional drive.



Available with ratings of 5 to 25 hp and with speeds from 30 to 84 rpm, the type GL has the advanced features of asbestos-protected windings, normalized castings, solid centricast rotors, and lubriflush lubrication. *Continued on Page 56*



# Niagara Aero Heat Exchanger quickly pulls down the initial peak load of heat in quenching . . . and saves cooling water

Accurate control of quench bath temperatures and quickly effective capacity to handle the initial peak load of heat in quenching prevents production set-backs, increases the output of your heat treating department, prevents oil fires, saves you losses from rejected parts.

Niagara Aero Heat Exchangers give you this control in both furnace and induction hardening methods. They prevent both over-heating and over-cooling of the quench bath. Hundreds of heat treaters know they prevent many troubles, constantly improve quality and increase production.

They quickly pay for themselves by saving cooling water coils and extend your quench capacity without extra water or cooling tower.

*Write for Bulletin #120 giving complete information.*

**NIAGARA BLOWER COMPANY**

Over 35 Years' Service in Industrial Air Engineering

**Dept. ME, 405 Lexington Ave.** **New York 17, N. Y.**

*Experienced District Engineers in all Principal Cities*

## • Keep Informed

### Copying Machine

Introduction of a new, low-cost Bruning Copyflex machine, the Model 20, for making copies in all phases of business and industry, has been announced by the Charles Bruning Co., New York, N. Y.

Because of its low cost, advanced engineering, and copying width, the new machine offers special value to both business and industry.

Engineers, designers, and chief draftsmen will find it ideal for the medium volume production of prints from tracings, engineering drawings, and other large-sized technical originals.

Accounting departments and business offices will find it an economical, timesaving tool for copying large-sized records, balance sheets, charts, and cumulative statistical statements and reports kept by the day, week, or month for production, inventory, sales, and cost control.

The new Copyflex machine offers a 46-in. printing width with exposure speeds up to 95 in. per min, and the price is lower than that of any other such machine in its volume range. It is a medium volume machine filling out the Bruning Copyflex line of five other models ranging from the heavy volume "93" to the recently introduced office, or secretarial, Model 12.

## • BUSINESS CHANGES

### Anniversaries

This year marks the 150th Anniversary of Revere Copper and Brass Inc., New York, N. Y. The company was founded by Paul Revere in 1801.

In Rochester, N. Y., the Taylor Instrument Companies are celebrating their centennial this year. Taylor are makers of temperature and weather instruments for the home, and temperature, pressure, humidity, flow, and liquid-level instruments for industry.

### B&W Tube Co. Moves Pacific Coast Office

Improved sales service for users, fabricators, and distributors of B&W seamless and welded stainless alloy and carbon steel tubing will be offered through the Babcock & Wilcox Tube Company's new sales headquarters in Los Angeles, Calif. The company's Pacific Coast Office, formerly located at 714 Olympic Boulevard in Los Angeles, will now be in larger quarters in the Lawson-Chipman Building at 1111 Wilshire Boulevard.

## • Keep Informed

**Clark Bros. Open New Sales Office**

The management of Clark Bros. Co., Inc., Olean, N. Y., announce the opening of new sales and service offices located at Pittsburgh, Pa. The territory covered by the new office, which is located at 2920 Koppers Bldg., was formerly served directly from the factory at Olean, N. Y.

**Westinghouse to Build New Warehouse**

The four-story warehouse being erected at East Pittsburgh by the Westinghouse Electric Corp. will rank among the most modern in the country.

For example, among the devices to be used to speed the flow of materials in and out of the building will be specially designed pallet-handling cranes, an electric eye "traffic cop," floating shipping docks that adjust to various truck heights, and a tele-talk communication system for last-minute instructions. Wherever possible, belt conveyers and endless chains will be used to move goods easily and quickly.

**Worthington Names New Sales Personnel**

The Worthington Pump and Machinery Corp., Harrison, N. J., has announced the appointment of Herbert E. Gallison as manager of the Industrial Mixer Sales Division with headquarters at the Dunellen, N. J. plant. He succeeds Mr. J. C. Lukas who has resigned.

Also announced by the company is the appointment of W. Clifford Mumford as Manager of the Vertical Turbine Pump Sales Division.

Mr. Mumford will have his headquarters at the Harrison, N. J. sales offices.

In addition Worthington has appointed William J. Fleming manager of the Construction Equipment Sales Division. John S. Bachman will continue in charge of field sales with the title of assistant manager. Both men will continue to make the Dunellen Works, Dunellen, N. J., their headquarters.

**Scrap Conservation**

A scrap conservation program at the Westinghouse Electric Appliance Division plant, Mansfield, Ohio, has added to appliance production and produced a savings estimated at $1,500,000 a year.

Vital materials such as copper, aluminum, brass, nickel, and steel—all made scarce by the nation's military program—are being culled from the division's appliance producing lines daily. Some of the material is reprocessed for further use; stamping methods are changed to stretch scarce steel; plating processes are improved to stretch copper and nickel supplies.

Back of the ability to produce dollar savings and the ability to stretch materials is the division's salvage department which began operations in 1935. Last year, this department recovered for further use in the production of appliances more than 23,000 tons of steel and more than 815,000 lb of nonferrous metals.

Paper cartons which could not be returned to suppliers were cut, scored, wrapped with new paper, and shaped into protective shipping pads. This process resulted in the production of 80,000 pads per month. In 1950, 40,000 bd-ft of lumber was recovered—enough lumber to crate 3300 refrigerators.

Over 160,000 gal of paint were recovered by using water wash paint spray booths that collect the excess paint that might otherwise be lost. Such paint is reprocessed and is suitable for many production operations.

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### Whitney Chain to Build New Plant

The National Production Authority has granted the Whitney Chain Co., Hartford, Conn., a Certificate of Necessity to expand its manufacturing capacity. The Certificate will be applied against erecting and equipping a new plant in Longview, Texas.

Construction of the new plant will enable Whitney Chain to be nearer their petroleum, mining, and agricultural markets and complies with the recommendations of the Government for dispersal of essential industries to less strategic areas. It is estimated that approximately 18 months will be required to prepare this additional chain and sprocket manufacturing facility.

### Kellex Corp. Changes Name

The Kellex Corp., specialist research and engineering firm, announced that it has changed its name to Vitro Corp. of America. The change in name became effective August 31 but organization, policies, and services will continue as before.

Main offices of Vitro Corp. of America will remain at 233 Broadway, New York, N. Y. The corporation operates research and development laboratories in West Orange and Jersey City, N. J., and in Silver Spring, Md.

### Worthington to Modernize Oil City Plant

A $500,000 modernization of its Oil City, Pa., plant is planned by Worthington Pump and Machinery Corp. Plans include re-equipping the present foundry and establishing a new electric power supply.

New molding machines, sand conditioning, and sand-supply equipment will be installed in the plant. Mechanization includes installation of overhead crane service at all working stations and 500 ft of roller conveyers.

### Griscom-Russell Moves General Offices to Massillon, Ohio

On September 1, 1951, the Griscom-Russell Co. moved its general offices from New York City to Massillon, Ohio, where the Company's plant for manufacturing heat transfer apparatus of all types is located.

To accommodate the various departments, a new office building is being erected on the grounds of the Company's plant opposite the Massillon station of the main line of the Pennsylvania Railroad.

The Griscom-Russell New York office at 285 Madison Ave. will continue to operate as one of the more than 25 sales offices in the United States.

### De Laval Completes New Building

The De Laval Steam Turbine Company, Trenton, N. J., announces the completion of a new building at 160 Folsom St., San Francisco, Calif.

This building will be De Laval's new San Francisco headquarters for sales and service activities. Besides providing increased warehousing facilities for standard centrifugal pumps, IMO pumps, speed reducers, and flexible couplings, it will also permit much faster handling of repair and service orders for De Laval's western customers.

### Barnes-Gibson-Raymond Moves

Barnes-Gibson-Raymond, division of Associated Spring Corporation, announces the removal of its business to a new, larger plant at 40300 Plymouth Road, Plymouth, Mich., from 6400 Miller Ave., Detroit, Mich. Operation commenced on Sept. 1, 1951, on the manufacture of mechanical springs, wire forms, and small stampings.

## • Keep Informed

**Worthington Pump Opens New Office**

Worthington Pump and Machinery Corp., Harrison, N. J., has opened a branch office in Harrisburg, Pa. at 506 Hall Building, 2nd and Locust Streets.

**Westinghouse to Start Defense Production at Metuchen**

Limited defense production is expected to start at the New Westinghouse Television-Radio Division plant at Metuchen, N. J. Approximately 200 people will be employed by the end of the year. Skilled and semi-skilled factory employees are being hired to work as testers, inspectors, and assemblers. A majority of the employees on the assembly line will be women. Only a small portion of the plant's 400,000 sq ft of manufacturing space will be used at first, and all production will be "confidential equipment of an electronic nature for the Armed Forces."

## • LATEST CATALOGS

**Electric Process Heating**

Advance Heating Division, Jensen Specialties, Inc., Detroit, Mich., has issued a 6-page bulletin covering electric process heating. Ovens, driers, and booster heaters may now be assembled on-the-job from fully insulated low-cost prefabricated construction built to standardized dimensions, according to the bulletin.

**Chemical Service Pump**

A four-page two-color bulletin, No. WQ-213, devoted to Type "G" pump for process and chemical plants having semicritical requirements has been published by Warren Steam Pump Co., Inc., Warren, Mass. The pumps are available in 1, $1^1/_4$, $1^1/_2$, and 3-in. discharge sizes and heads to 240 ft. Bulletin includes specifications, dimensions, and selection chart; also external and sectional views.

**Chain Drives**

A new catalog, No. HD-51, to assist in chain-drive selection, has been released by Whitney Chain Co., Hartford, Conn. The catalog offers a simple quick means of determining interchangeability of various makes of roller and conveyer chains. Information useful in determining the proper application of chain drives as a power transmission or conveying medium, is included.

**Springs**

"How to Keep Springing Costs Down," is the title of a four-page leaflet now available from Dudek & Bock Spring and Mfg. Co., Chicago, Ill. Information on Dudek & Bock's manufacturing facilities plus the company's manufacturing variations for coil springs is included.

**Constant Delivery Pumps**

New 4-page bulletin No. 46601 issued by the Oilgear Co., Milwaukee, Wis., illustrates and describes three new constant delivery axial piston pumps for pressures up to 3000 and 5000 psi. These units incorporate balanced flat valves (port plates), simple one-piece rolling pistons, and reverse-flow high-pressure and supercharging pressure relief valves. The 100% supercharge permits smaller intake passages, reduces area of flat valve, minimizes compression of oil, eliminates entrance of air, and assures quieter operation.

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## • Keep Informed

### Resistance Welding of Nickel Alloys

A new technical booklet No. T-33, on the resistance welding of nickel and high nickel alloys is available from the Development and Research Division of The International Nickel Co., Inc., New York, N.Y. It presents tables on mechanical properties, chemical compositions, recommended conditions for welding, and other information.

### Packaged Electric Power

A new 24-page bulletin, No. GEA-5600, on packaged electric power for industry's third—and biggest—expansion is now available from the General Electric Co., Schenectady, N.Y.

The publication outlines methods of obtaining electric power equipment for quick expansion at low cost and with a minimum of critical materials.

Use of "packaged" electrical systems simplifies plant engineering problems, cuts equipment and installation costs, conserves vital materials and manpower, and insures quicker delivery of electrical equipment, according to the bulletin.

### Copper Corrosion Studies

The results of studies of the nature of corrosive attack on copper and copper alloys have been published in a 24-page booklet, No. B-36, "Corrosion Resistance of Copper and Copper Alloys," by American Brass Co., Waterbury, Conn. The booklet explains the chemical and physical nature of corrosive attack in its various forms. Included is a tabulation indicating the relative corrosion resistance of the principal types of copper and copper-base alloys when in contact with 183 different corroding agents.

### Electrical Measuring Instruments

Information on how to select electrical measuring instruments is provided in a 30-page instrument booklet, No. B-4696 available from the Westinghouse Electric Corp., Box 2099, Pittsburgh, Pa.

Seven basic selection factors are explained; types of instruments available in each major classification are listed on a full-page check chart; and four typical selection problems are solved to help the reader make his selection.

### Hydraulic Power Units

A new 12-page bulletin, No. 210, which illustrates and describes a new line of hydraulic power units and bell-mounted motor-pump units is available from Haskel Engineering & Supply Co., Glendale, Calif. It lists all of the company's 312 standard models and presents detailed performance and application information and recommendations for the selection and installation of hydraulic power units for any specific power requirement. Information on custom-built models and extra equipment available for use on the standard models, is included.

### Standard Screw Products

Standard Pressed Steel Co., Jenkintown, Pa., tell just what UNBRAKO "standards" are and the advantages of using standard screw products, in a new booklet.

Entitled UNBRAKO "Standards," the booklet contains detailed information about: Socket head cap screws; self-locking socket set screws; socket set screw points; flat head socket cap screws; shoulder screws or stripper bolts; dryseal-thread pressure plugs; socket screw keys; square head set screws; precision-ground dowel pins.

## • Keep Informed

### Selecting Engineering Irons

A new 28-page basic reference bulletin, compiled primarily for design engineers, is available from International Nickel Co., Inc., Dept. EZ, New York 5, N.Y. It presents the many valuable characteristics of modern nickel cast irons and illustrates their broad acceptance throughout industry. 50 illustrations indicate wide industrial usage in all sizes and shapes. 27 useful tables, charts, and photomicrographs show how through the use of nickel, alone or in combination with other alloying elements, the engineering properties of cast iron can be controlled to meet almost any reasonable combination of service requirements.

### Multiroom Air Conditioning

Full technical data for laying out year-round air conditioning for offices, hotels, hospitals, apartments, and other multiroom structures are contained in a new 36-page bulletin, No. DS-369, on the Trane Custom-Air system, available from the Trane Co., La Crosse, Wis.

The bulletin outlines criteria for design of the ventilation air system; room unit selection and performance data; roughing-in dimensions; mechanical specifications and control systems.

### Rotary Condensate Meters

A new 4-page bulletin, No. R-513, issued by American District Steam Co., North Tonawanda, N.Y., explains design, construction, installation, and operation of the ADSCO rotary condensate meter. It is said to be the most economical means of determining steam consumption where all the condensate can be captured. The bulletin includes size, dimension, and weight table, and simplified piping diagrams for both gravity and vacuum systems.

### Strain Gages in Industry

Four ways in which Baldwin SR-4 weighing units are being used for industrial weighing are briefly described in a new 4-page bulletin issued by Baldwin-Lima-Hamilton Corp., Philadelphia, Pa. Applications include crane hooks, multitank weighing and batch control of liquids, continuous weight integrator for materials carried by belt, and an axle-scale for loaded highway trucks.

### Scraped Surface Exchangers

A new bulletin, No. PE-1, covering scraped surface exchangers is available from Henry Vogt Machine Co., Louisville, Ky. It describes and illustrates the two basic types of scraped surface equipment; namely, the double pipe type and the shell and pipe type. In either form the solution to be cooled or heated flows inside a series of 6-in. pipes connected by heavy return bends. The inner surface of the 6-in. pipes is continuously scraped clean by rotating flights of scraper blades. The outer surface of the 6-in. pipes may be cooled by water, refrigerated brine, cold filtrate, or boiling refrigerant, or heated by steam or other heating mediums.

### Belt Conveyer Idlers

A new 42-page illustrated bulletin, No. 51-81, published by Chain Belt Co. of Milwaukee, Wis., gives engineering information about numerous styles of belt conveyer idlers. Also covered are belt conveyer trippers, take-ups, cleaners, cast-iron conveyer pulleys, steel conveyer pulleys, and maintenance of belt conveyer idlers.

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## • Keep Informed

### Alloy Steel Tubing

Assistance in solving problems involving the use of alternate grades of medium carbon or full hardening grades of tubing steels, is offered in a new four-page bulletin No. TDC 141, published by The Babcock & Wilcox Tube Co., Beaver Falls, Pa. It presents condensed data on microstructure, critical points, effect of alloy elements, forging, machining, welding, and thermal treatment for 14 well-known alloy steels used in the production of tubular parts.

### Power System Equipment

A new 16-page bulletin, No. GEA-5521, describing power system equipment for pulp and paper mills is now available from the General Electric Co., Schenectady, N.Y.

The bulletin reports on G-E products aimed at adding greater reliability to the electric power systems of pulp and paper mills.

### Vertical Turbine-Type Pumps

Ingersoll-Rand Co., New York, N.Y., has prepared an eight-page catalog, No. 7228, which describes the Class APH-APK line of vertical, turbine-type pumps. These pumps are particularly applicable to bulk liquid transfer, cooling tower, dewatering, and similar services where suction is taken from an open source. Available in single or multi-stage construction, with any desired column length, Class APH-APK pumps range in size from 6 to 30 in., for capacities to 15,000 gpm and pressures to 250 psi. Either open, water-lubricated shaft, or oil-lubricated enclosed shaft constructions are available.

### Copper Clad Metal

American Cladmetals Co., Carnegie, Pa., has issued a new booklet entitled "Electro-shield, the new Copper Clad Metal." It is of vital importance to every user of copper, especially during these days of scarcities, because of two major reasons. First, Electro-Shield saves up to 80% of copper; second, it can be used for most applications where copper sheets are now employed, and more. This booklet provides the answer to many present-day production problems where copper restrictions might cause serious upsets in design.

### Forced-Draft Fans

The Prat-Daniel Corp., is offering a new eight-page illustrated bulletin, describing the design features of their new forced-draft fans.

The booklet illustrates various types of fan-wheels, designed with precisely shaped backward curved blades, that permit an almost perfect flow of air from leading and trailing edges. Various types of housing are also shown, as well as a complete list of representatives of The Thermix Corp., Greenwich, Conn., to whom all requests should be sent. Ask for bulletin No. 300.

### Veneer-Lathe Drives

A new four-page bulletin, No. GEA-5596, on electric veneer-lathe drives with amplidyne control now is available from the General Electric Co., Schenectady, N.Y. The two-color publication, uses nine photographs and a diagram in outlining the advantages of the new drives. The drives are available in all standard sizes up to 150 hp and higher. They are designed to give plywood producers high quality veneer, increased output, reduced waste, simplified lathe operation, reduced maintenance costs, and operational economy.

## • Keep Informed

### Chains and Sprockets

A new catalog No. C 55-50 of stock roller chains and sprockets has been announced by Morse Chain Co., Detroit, Mich. The catalog gives details on list prices, available sizes of types A, B, and C Morse stock sprockets, and pertinent information on Morse stock roller chain from 3/8-in. pitch to 2-in. pitch. Also included are data on drive selection, service factors, installation, and service.

### Regulators

The O. C. Keckley Co., Chicago, Ill. has just issued a new bulletin No. 751 illustrating and describing precision pressure regulators, temperature regulators, and combination pressure and temperature regulators. It includes dimensions, application, capacity, engineering tables, and specifications.

### Vibrating Screens

A new 20-page illustrated book No. 2377 on Model "UP" Vibrating Screens for the fast accurate dry-screening of light and fine materials, and Model "NRM" Liquid Vibrating Screens for the low-cost high-speed separation of solids from liquids, has been published by Link-Belt Co., Chicago, Ill.

Both types of screens are available in a wide range of sizes. The "UP" can be furnished with single or multiple decks, and with semienclosed or totally enclosed steel housings where required.

Descriptive material includes specific information on how to select the right screen and screen cloth for maximum operating efficiency; dimension tables, weights, horsepower requirements; and other data of value to the engineer and plant operator.

### Water Softeners

A bulletin published by Permutit Co., New York, N.Y., describes how the effluent from hot lime soda softener is reduced to zero hardness by Permutit hot zeolite process. It is pointed out that it is possible to have boiler feed water low in alkalinity, low in silica, and with all traces of hardness removed by passing the raw water first through a Permutit Hot Process Softener and second through a Permutit Zeolite (Ion Exchanger) Softener. In the first step, alkalinity is lowered, silica is reduced, and some hardness is removed. In the second step, all residual calcium and magnesium are removed.

### Boiler-Room Modernization

An 8-page case history, Bulletin No. R-6, telling of the modernization and expansion in the boiler room of Falstaff Brewing Company's Plant No. 5, St. Louis, Mo., is now available from Hays Corp., Michigan City, Ind. New equipment added, building changes, uses for steam and boiler conditions, are described and illustrated.

### Coal-Flow Stokers

Accurate adjustment of the coal-feeding rate to the exact load demand is being achieved by Iron Fireman Manufacturing Co., Cleveland, Ohio, through its exclusive infinitely variable transmission on two of its coal flow stoker series described in a new bulletin.

An exclusive feature with its CF series coal flow stokers and PCF series Poweram coal flow stokers, the variable drive is particularly suited for use with modulating-type combustion controls. Infinite speed range is provided by a simple durable mechanism that eliminates many of the service and adjustment problems characteristic of most variable-speed drives.

*Continued on Page 64*

# • Keep Informed . . .

### Super Refractories

A new 20-page booklet on super refractories is available from The Carborundum Co., Refractories Div., Perth Amboy, N.J. It gives technical information of a basic nature on these products. The text material is supplemented with charts, tables, and illustrations that should be particularly valuable.

### Valves

The following literature is available from Klipfel Mfg. Co., Div. of Hamilton-Thomas Corp., Hamilton, Ohio: Bulletin No. 148 on reducing valves; folder No. 135M covering multiport back-pressure valves; bulletin No. 349 on float valves; No. 449 on thermostatic valves; and No. 648 on back pressure valves.

### Air-Cooled Engines

Latest literature published by Wisconsin Motor Corp., Milwaukee, Wis., points up the versatility of Wisconsin air-cooled engines and the major part they play wherever portable power is required, particularly on equipment to serve the farm, construction, industrial, and oil fields.

### Squirrel-Cage Induction Motors

Construction features of large end-shield bearing squirrel-cage induction motors are described in a new bulletin, No. 05B7542A, issued by Allis-Chalmers Mfg. Co., Milwaukee, Wis. Built for a wide range of applications from central station auxiliary to general industrial drives, these motors are available in ratings and speeds up to 1750 hp at 1800 rpm.

### Nickel-Alloy Pipe and Tubing

A new 27-page, illustrated bulletin, No. T-17, on the fabrication and design of nickel and high-nickel-alloy pipe and tubing has been issued by the Development and Research Division of The International Nickel Co., Inc., New York, N.Y. It presents tables on mechanical and physical properties, ASME code requirements, recommended welding procedures, and other information.

### Vibration Reduction

A simplified method for selection of the right grade and weight of vibration mounting felt has been developed by the American Felt Co., of Glenville, Conn., and is described in a new booklet prepared for industry entitled "How to Reduce Vibration."

The booklet points out that when a machine is properly mounted on vibra-mount felt, it rests on a resilient cushion which substantially reduces the amount of vibration transmitted to the floor. Tests by American Felt Company engineers show as much as an 85 per cent reduction in transmitted vibration after such an installation.

### Steel Tubing

Technical data on tubing for the petroleum, chemical, pulp and paper, food, and pharmaceutical processing industries is presented in a new eight-page illustrated bulletin No. TA-1559, published by The Babcock & Wilcox Tube Co., Beaver Falls, Pa. Analyses and tables of physical and mechanical properties as well as application data for 20 popular carbon, alloy, and stainless tubing steels are given.

### Packaged Printing-Press Controller

A new four-page two-color bulletin, No. GEA-5614 on packaged a-c full-automatic printing-press drive controllers is available from the General Electric Co., Schenectady, N.Y.

The publication describes the features and application of the new equipment, which was designed especially for weeklies and small dailies in ratings from 40 to 75 hp.

### No-Frost Concentrator

Two new pieces of literature are available from Niagara Blower Co., New York, N.Y. Bulletins No. 118, Series 6600 and No. 119, Series A cover the Niagara no-frost concentrator.

### Steam Traps

A 20-page supplement, T-1750, to the new 24-page Yarway steam trap bulletin No. T-1740, is now available from Yarnall-Waring Co., Philadelphia, Pa. This trap selector is particularly useful for engineers who have many applications for steam traps.

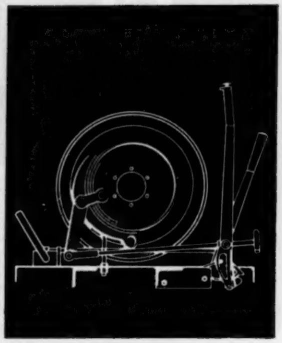
### Worm-Gear Speed Reducers

A new folder issued by Cleveland Worm and Gear Co., Cleveland, Ohio, pictures and describes several of Cleveland's speed reducer units. Among them are the type CU unit, built to take the punishment of cooling-tower service—the Speedaire fan-cooled reducer, for use where space and weight are at a premium—and also a special unit designed by Cleveland for an unusual application, in this case driving a woolen card.

# A Problem of Speed Plus Accuracy—

# SMOOTH, RESPONSIVE BRAKES

## GIVE POSITIVE CONTROL!



**Because of the need for accurate and dependable control of rotation speeds under severe weather and working conditions, a TDA Duo-Grip Brake is standard equipment on the Halliburton Measuring Reel. The machine lowers a wire measuring line and instruments into oil wells at speeds up to 1,100 feet per minute. The manufacturer states: "This brake gives good braking effect with little effort on the brake lever without sacrificing sensitivity and accurate control." Some have been in service for three and one-half years without relining—a clear indication of their excellent performance!**

## WHATEVER *YOUR* BRAKING PROBLEM— TAKE IT TO TDA BRAKE DIVISION!

It's hard to think of a more important factor of machine operation than *control.* When the rotation of equipment must be retarded for a time—or brought to a full stop—this matter of control becomes a task for efficient, properly designed brakes. That is why more and more machine manufacturers are turning to TDA Brake Division. Backed by more than 40 years of concentrated experience in the field, thoroughly qualified specialists are available to analyze your brake needs and to supply equipment precisely engineered for your specific purposes. TDA Brakes can improve your product's performance and reduce your customer's maintenance expense. Mail the coupon below—*today!*

***Here Are A Few Of The Many Products Which Can Be Equipped With TDA Brakes***

**Centrifuges • Compressors • Conveyors • Cranes Cream Separators • Diesel hook-ups • Dry cleaning machinery • Extractors • Hoists • Industrial electric trucks • Lathes (automatic) • Looms (textile) • Lumber mill machinery • Machine tools • Materials handling equipment • Motors • Packaging machinery • Paint mixers • Press brakes • Printing presses • Rolling mills • Shears • Warpers (textile) • Welding positioners • Winches • Automotive • Farm equipment Earth moving equipment • Construction equipment Public transportation**

IF IT ROTATES WE CAN BRAKE IT

TDA BRAKE DIVISION—DEPT. D-1
ASHTABULA, OHIO
Please mail brake information on these applications.

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COMPANY ______________________________

ADDRESS ______________________________

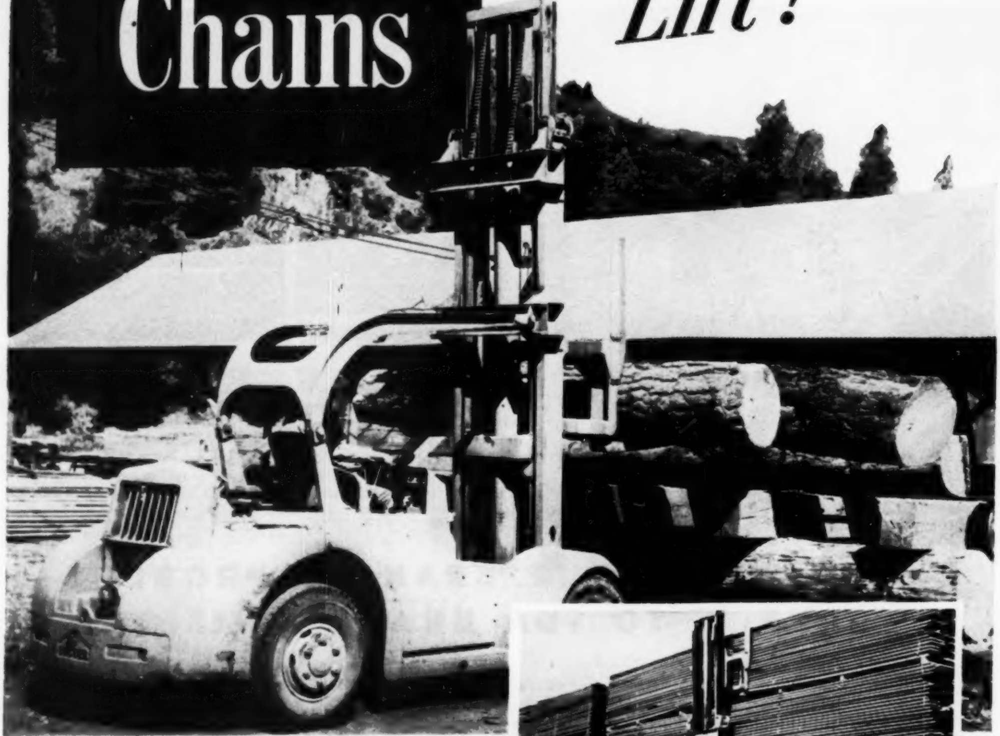
CITY ______________ STATE ______________

**TIMKEN Detroit BRAKES**
TDA BRAKE DIVISION
THE TIMKEN-DETROIT AXLE COMPANY
ASHTABULA, OHIO

The Accepted TDA Standard
TRADE MARK REGISTERED

# Whitney Chains

## *Help "Hyster" Make a Big Lift!*



The 7½ ton "Hyster 150" gasoline-powered lift truck is a husky baby . . . handles loads quickly and efficiently. Its long 48" load arms pick up, stack, hold and place large and small loads easily — saves time and money in materials handling.

This kind of performance demands a chain drive that will stand up under severe operating conditions. That's why Hyster Company selected Whitney Chains for the elevating unit, to insure smooth positive operation and long service with minimum maintenance.

Maybe lift trucks aren't your problem. But if you have a power transmission design involving long or short centers, reversal of direction, timing motions, fractional or hundreds of horsepower, it will pay you to find out what precision built Whitney Chain Drives can do for you. We've been solving similar power transmission and conveying problems for over a half century.

Can we help on yours?

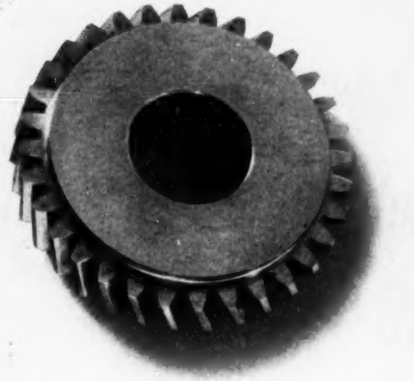
Consult your local Whitney Field Office or Distributor, or write direct to us for complete information and catalog.

**WHITNEY CHAIN COMPANY**

**240 Hamilton Street, Hartford 7, Connecticut**

## Kodak Conju-Gage Gear Checkers deliver

# *A fundamental improvement in quality control of gearing*



**RESULTS—toolroom precision... versatility... fast checking... no questionable rejection losses**

Gear manufacturers and engineers are meeting the requirements for increased production of tighter and tighter tolerance gears with improved precision manufacturing equipment. Invaluable in quickly checking and controlling the quality of this tight-tolerance production are Kodak Conju-Gage Gear Checkers.

The fundamental principle around which Kodak Conju-Gage Gear Checkers are designed is a new kind of gaging element—the Kodak Conju-Gage Worm Section—inherently simple and accurate in form—made to tolerances almost impossible to obtain in circular master gears, especially in finer pitches.

A single Kodak Conju-Gage Worm Section of given normal pitch and pressure angle checks any corresponding spur or helical gear of any helix angle. It checks the composite effect of runout, base pitch error, tooth thickness variation, profile error, and lateral runout, as recommended in the new American Standard.* Lead error, crown, and taper can also be checked and applied to standard quality control inspection procedures.

Kodak Conju-Gage Gear Checker, Model 4U, tests gears up to 4⅛" pitch diameter. Automatically writes records to ship with gears or to hold for reference. Larger and smaller models are also available.

Anyone interested in the fundamental improvement of quality control of gearing will find the booklet, "Kodak Conju-Gage Gear Testing Principle," extremely helpful. It's yours for the asking. Eastman Kodak Company, Industrial Optical Sales Division, Rochester 4, N. Y.

*To those interested, we shall be happy to present, with our compliments, a copy of the new American Standard, "Inspection of Fine-Pitch Gears" (AGMA 236.03, ASA B6.11-1951).

**CONJU-GAGE INSTRUMENTATION**

***...a new way to check gear precision in action***

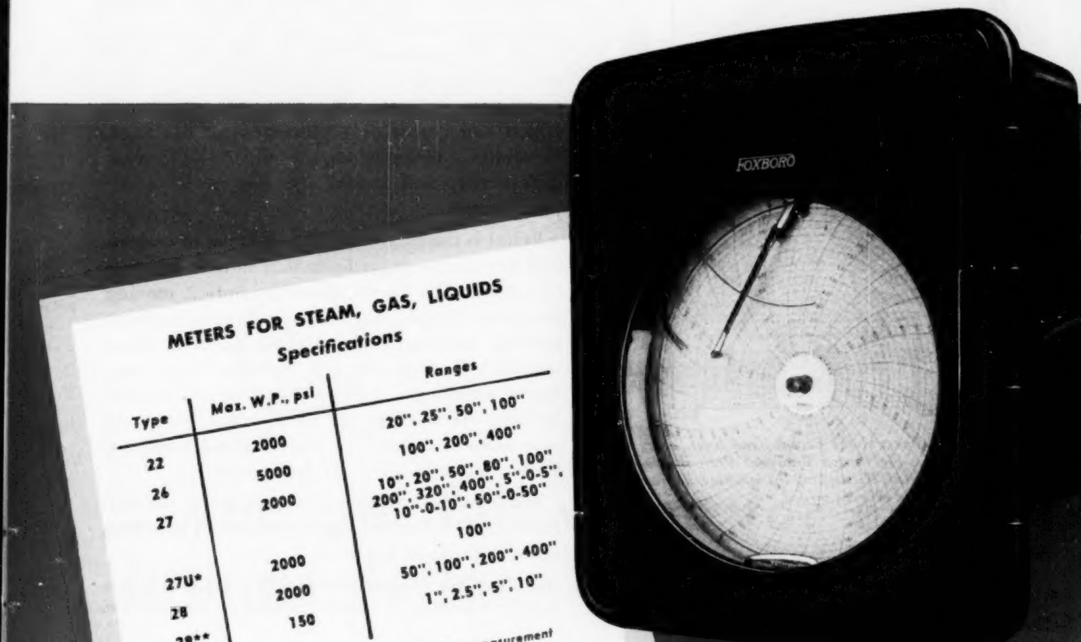
Kodak

# Higher sustained accuracy, less maintenance than ever before!

Outstanding improvements in every basic detail of differential meter design now afford a new complete line of Foxboro Flow Meters that set an unprecedented standard of dependable accuracy.

In addition to the important features outlined on the opposite page, these new meters retain all the uniquely advantageous features of the previous Foxboro line, including large floats with long travel for added power; and floats located in high pressure chamber to minimize ambient temperature effects. The combined result is practical metering performance that's farther ahead of the field than ever before . . . in maintenance-freedom as well as sustained accuracy.

Check up on all the advantages of the new Foxboro Flow Meters. Available in round or rectangular cases . . . as indicators, recorders, controllers or transmitters . . . with or without integrators. There's a type for every metering problem. Write for New Bulletin 460. **The Foxboro Company, 18210 Neponset Ave., Foxboro, Mass., U.S.A.**




**METERS FOR STEAM, GAS, LIQUIDS**
**Specifications**

| Type | Max. W.P., psi | Ranges |
|---|---|---|
| 22 | 2000 | 20", 25", 50", 100" |
| 26 | 5000 | 100", 200", 400" |
| 27 | 2000 | 10", 20", 50", 80", 100", 200", 320", 400", 5"-0-5", 10"-0-10", 50"-0-50" |
| 27U* | 2000 | 100" |
| 28 | 2000 | 50", 100", 200", 400" |
| 29** | 150 | 1", 2.5", 5", 10" |

*Formed range chamber for uniform scale flow measurement
**Bell Type

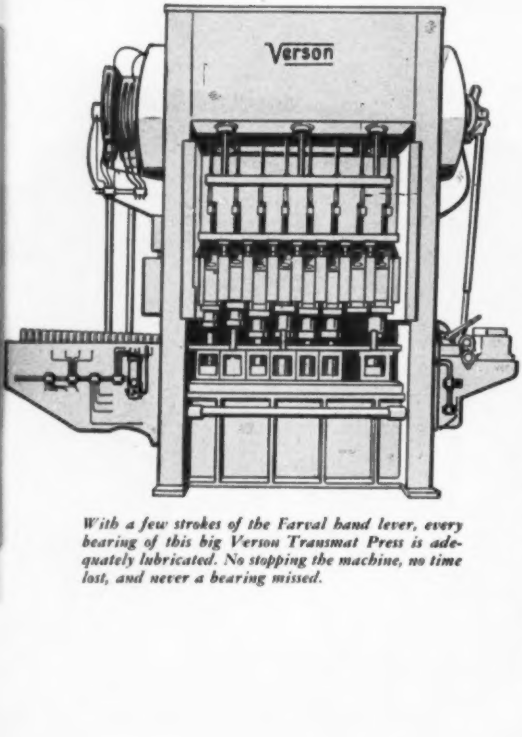
## . . . *First in FLOW METERS*

# 30 million stampings without a bearing failure

## ...thanks to Farval lubrication

FARVAL—*Studies in Centralized Lubrication*
No. 123

VERSON built and installed this high-speed Transmat Press in a metal-working plant in 1946. It was factory-equipped with a Farval system of Centralized Lubrication. In the five years since its installation, the machine has never been shut down for lubrication, for bearing replacement, or, in fact, for anything other than ordinary preventive maintenance.




*With a few strokes of the Farval hand lever, every bearing of this big Verson Transmat Press is adequately lubricated. No stopping the machine, no time lost, and never a bearing missed.*

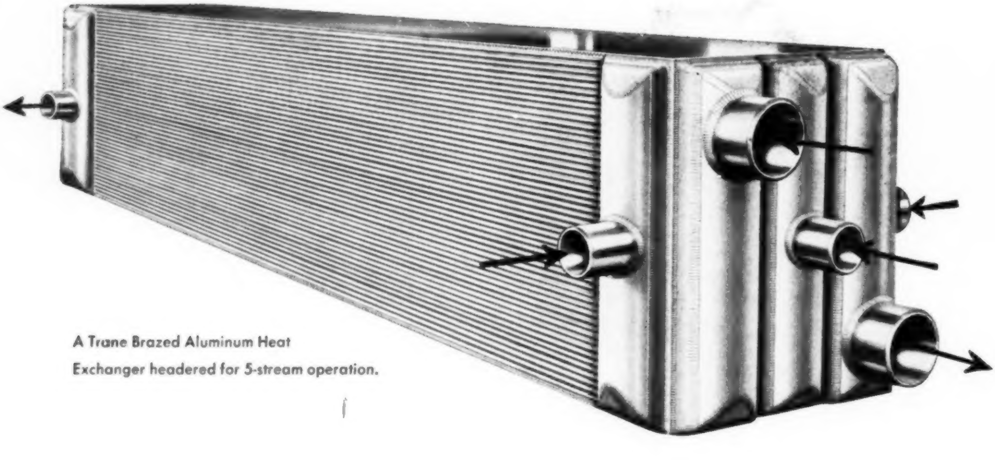
The press is used for progressive dieing. Coil stock is fed into the blanking station and then carried by a finger feed for several succeeding operations. It works at the rate of 22 strokes per minute. In continuous operation for five years, this press has turned out in excess of 30,000,000 stampings. By eliminating down time for lubrication and repair or replacement of bearings, Farval has contributed importantly to this impressive output—and should continue to do so for years to come.

Farval is the original Dualine system of centralized lubrication proved practical in over 20 years of service. The Farval valve has only 2 moving parts—is simple, sure and foolproof, without springs, ball-checks or pinhole ports to cause trouble. Through its full hydraulic operation, Farval unfailingly delivers grease or oil to each bearing—as much as you want, exactly measured—as often as desired. Indicators at every bearing show that each valve has functioned.

For a full description of Farval, write for Bulletin 25. The Farval Corporation, 3264 East 80th Street, Cleveland 4, Ohio.

*Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.*

FARVAL
CENTRALIZED SYSTEMS OF LUBRICATION



A Trane Brazed Aluminum Heat Exchanger headered for 5-stream operation.

## This Single Brazed Aluminum Heat Exchanger

# Handles FIVE Fluids Simultaneously

**Trane Brazed Aluminum Heat Exchangers** can be designed to handle up to five streams, or even more, at the same time – and meet the heat transfer needs of each stream accurately and efficiently.

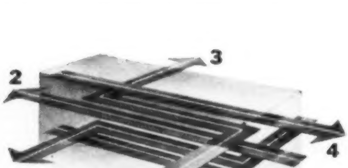
A single unit can be made to handle two, three, four, five or even more different liquids or gases. Headers are designed specifically for your installation. You can take any stream off at any point in the exchanger. You can split a stream, taking part off at one point in the unit at a given temperature and pressure, the rest off at another point at different conditions. The units provide just the heat transfer, pressure drop, volume, velocity, number and direction of passes needed for each stream.

And the units can meet these heat transfer specifications in the most limited space. That's because the Trane Brazed Aluminum Heat Exchangers pack up to 450 square feet of heat transfer surface into one cubic foot – nine times more than a tubular exchanger with ¾" tube.

Since a smaller unit can do a bigger job, *Brazed Aluminum Heat Exchangers can often replace tubular exchangers costing two or three times more and weighing four times more.*

These all-aluminum Trane Heat Exchangers are rugged, too. They take test pressures up to 1,000 lbs. per square inch, and temperatures from –300° to 500°F.

Whether the job calls for high or low temperatures or pressures, for one stream or many – as long as efficiency and economy are important – Trane Brazed Aluminum Heat Exchangers can be the answer. Contact your nearest Trane sales office or write direct.




Symbolic drawing, left, shows one of many ways in which a Trane Brazed Aluminum Heat Exchanger may handle up to five fluids simultaneously.

**TRANE**

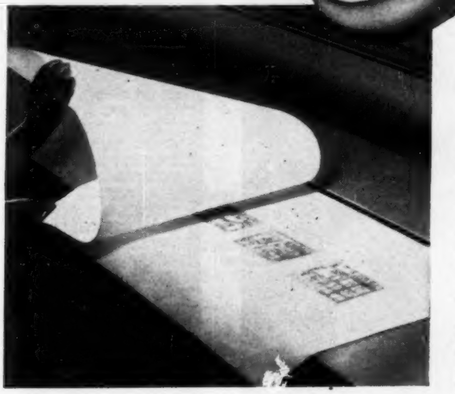
THE TRANE COMPANY, LA CROSSE, WISCONSIN
Eastern Mfg. Division . . . Scranton, Pennsylvania
Trane Company of Canada, Ltd. . . . . . Toronto
OFFICES IN 80 U. S. AND 14 CANADIAN CITIES

**MANUFACTURING ENGINEERS OF HEATING, VENTILATING AND AIR CONDITIONING EQUIPMENT**

# More time for creative drafting!

**Look at just two of the ways** Kodagraph Autopositive Paper saves valuable drafting time for the Cleveland Crane and Engineering Company.

The chances are you'll be able to take similar short-cuts in your work . . . *turn hours of costly retracing time into hours of creative drafting time.*



**1 Time saved . . . when drawings must be combined**

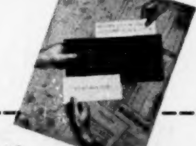
Many clients order custom jobs requiring electrical components which Cleveland Crane must obtain from outside vendors. Oftentimes, the designs for several of these units must be combined in one drawing before original drafting can begin. This used to be a tedious retracing job—*but no longer.* Now, desired sections of the vendors' prints are reproduced as a composite print on "Autopositive" Paper. Exposure is in a direct-process machine; processing is in standard photographic solutions. The result is a sparkling positive intermediate . . . with dense photographic black lines on a clean, evenly translucent base. On it, the draftsman simply adds the necessary wiring detail . . . producing a new "master" in a fraction of the old time.

**2 Time saved . . . when drawings must be changed**

New design must replace old detail on complicated switch assembly drawings. *And Cleveland Crane is doing the job the easy way:* instead of making a new drawing—which would be 85% retracing—they reproduce the original one on Kodagraph Autopositive Paper. Then the draftsman removes the unwanted lines from the intermediate print with corrector fluid . . . and draws in the new detail. Result: a brand-new "original" is ready in three hours instead of 3 days. *Ready* to produce sharp, legible shop prints in the desired number.

## Kodagraph Autopositive Paper

**"The Big New Plus" in engineering drawing reproduction**



—MAIL COUPON FOR FREE BOOKLET—

- **It enables you, or your blueprinter, to produce positive photographic intermediates directly at a new, low cost.**
- **It enables you to reclaim old, weak-lined drawings . . . reproduce opaque originals and prints.**
- **It protects your valuable originals . . . produces more legible shop prints.**

**EASTMAN KODAK COMPANY**
**Industrial Photographic Division, Rochester 4, N. Y.** 16

Gentlemen: Please send me a copy of your illustrated booklet giving all the facts on Kodagraph Autopositive Paper.

Name__________ Position__________

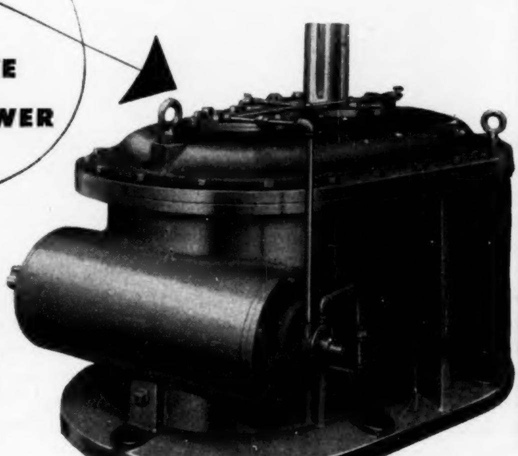
Company__________ Street__________

City__________ State__________

Kodak
TRADE-MARK

# have you a drive problem?

**A FOOTE BROS.**
**WORM-HELICAL DRIVE**
**MAY PROVIDE THE ANSWER**



● Rugged strength, the ability to stand up under punishing loads, the highest possible efficiency — these are characteristics of Foote Bros. Worm-Helical Drives.

Input shafts are horizontal, output shafts vertical, up or down — making these units ideal for use in chemical plants, pulp mills or wherever materials must be agitated or mixed.

Foote Bros. Worm-Helical Drives are available in ratios from approximately 25 up to 285 to 1—capacities up to 128 h.p. See your Foote Bros. representative or mail the coupon for information.

FOOTE BROS. GEAR AND MACHINE CORPORATION
4545 S. Western Boulevard • Chicago 9, Illinois

**Whatever your requirements in power transmission, you will find exactly the drive best suited to your needs in the complete Foote Bros. line of enclosed gear drives and gearmotors. Check the coupon indicating the drive in which you are interested.**

FOOTE BROS.

*Better Power Transmission Through Better Gears*

Foote Bros. Gear and Machine Corporation
Dept. Q., 4545 S. Western Boulevard, Chicago 9, Illinois
Please send bulletins on drives checked below.

- ☐ WORM-HELICAL DRIVES
- ☐ LINE-O-POWER STRAIGHT LINE DRIVES
- ☐ MAXIPOWER HELICAL GEAR DRIVES
- ☐ HYGRADE WORM GEAR DRIVES
- ☐ FOOTE BROS.-LOUIS ALLIS GEARMOTORS

*Name*..........................................
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# *Masterpiece* by CROMOVAN

100,000 pieces per grind . . . 100% increase in production over former dies . . . is the outstanding performance of this Cromovan six station, progressive lamination die. The die punches out both rotor and stator laminations complete . . . from .025 silicon lamination sheets . . . clearance tolerance of .0007 inch per side is strictly maintained between punches and die. All cutting surfaces of this die are made of CROMOVAN.

R248

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SEE THE NEW METHOD-X MACHINING SINTERED CARBIDES, SUPERALLOYS AND OTHER "NON-MACHINABLE" METALS.

**Firth-Sterling**

**STEEL & CARBIDE CORPORATION**

General Offices: 1330 Forbes St., Pittsburgh, Pa.

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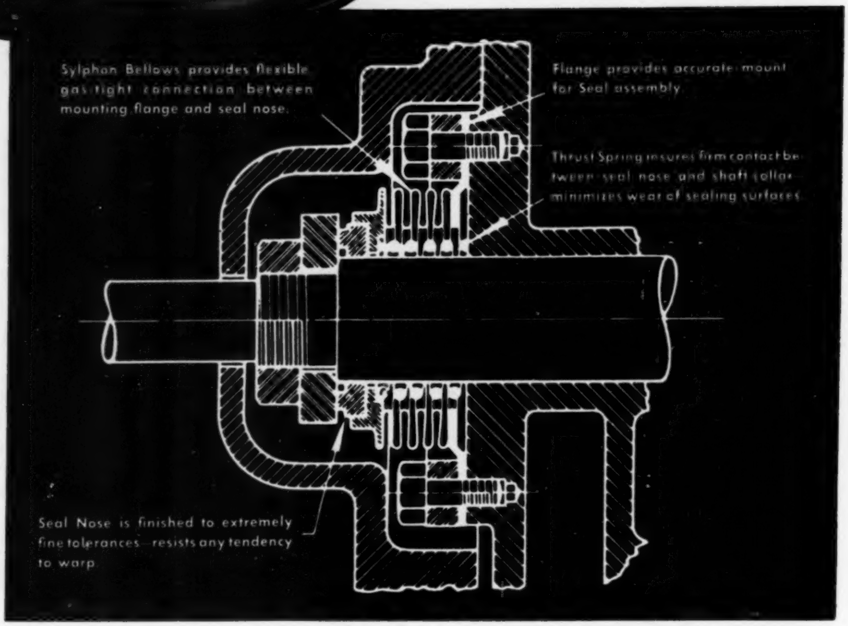
# It seals shafts gas-and-liquid-tight!




Rotating shafts can be made leak-proof—when you use Sylphon Seals. For these dependable seals hold firmly, withstand pressures up to hundreds of pounds. Friction is reduced, power is saved, shaft wear is minimized.

Sylphon Shaft Seals are engineered *on order,* for specific applications. They may be just what you need—for fluid transmissions, pumps, compressors, speed reducers, refrigerators or other units. Our engineers will gladly work with you on your requirements—help you with development work. Write for information, and ask for Catalog TK825.

TEMPERATURE CONTROLS

**FULTON SYLPHON** DIVISION
Knoxville 4, Tenn.

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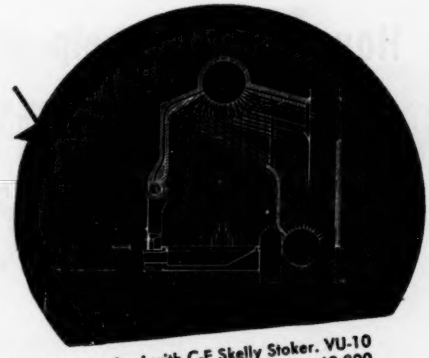
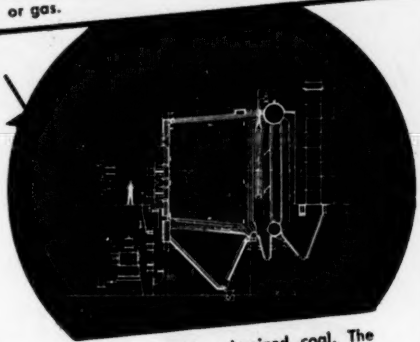
**BRIDGEPORT THERMOSTAT** DIVISION
Bridgeport 1, Conn.

BELLOWS ASSEMBLIES • BELLOWS DEVICES

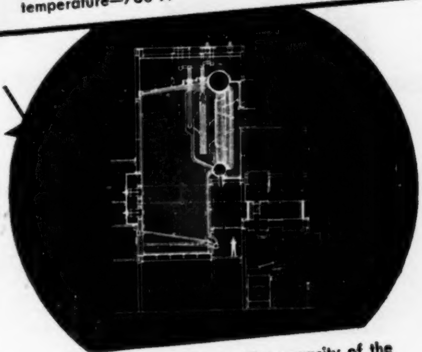
# Are VU boilers habit forming?



VU-10 Boiler fired with C-E Skelly Stoker. VU-10 Boilers range in capacity from 10,000 to 60,000 lb of steam per hour. They may be fired by underfeed, spreader or chain grate stokers or by oil or gas.



VU-50 Boiler fired with pulverized coal. The capacity of the unit shown is 150,000 lb of steam per hour; operating pressure—625 psi; total steam temperature—760 F.



VU-50 Boiler fired with oil. The capacity of the unit shown is 350,000 lb of steam per hour; operating pressure—920 psi; total steam temperature—905 F.

The record shows that they are. More than 100 companies . . . large and small . . . throughout this country and abroad . . . have ordered VU units more than once. Nearly half of these have ordered more than twice. Some as many as 5 or 6 times.

Considered in light of the fact that Vertical-Unit Boilers have never been — nor are likely to be — the cheapest you can buy, such a record becomes even more significant.

Here are just a few examples of the many industries that appear to have formed the VU habit.

**A Steel Company** now has a total of eleven VU Units in three different plants. Starting with an initial installation of three units in 1940, it has reordered twice; three units for a second plant in 1946 and five units for a third plant in 1950.

**An Electric Utility Company** started using the VU in 1944 when two units were installed at one of their power stations. When the capacity of this station was increased in 1948 two more units were installed. In 1947 this company ordered two more units for another of its stations.

**An Oil Company** ordered its first VU in 1937, its second in 1938. In 1942 another VU was installed and still another in 1944.

**An Aluminum Company** is another consistent buyer of VU Units. Since installing its first VU in 1940, it has reordered four times, and now has five C-E Vertical-Unit Boilers in service.

* * *

Just a small sample to be sure, but one that can be repeated over and over for other industries and other companies . . . companies that have ordered and reordered VU Boilers . . . companies that have the "VU habit" and find it highly profitable. B-511A

C-E

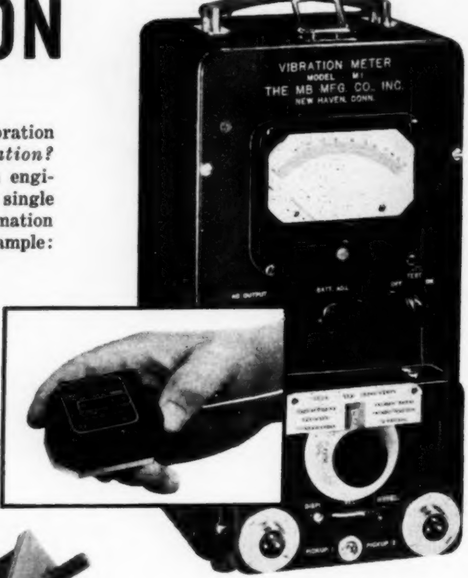
**COMBUSTION ENGINEERING—SUPERHEATER, INC.**

**Combustion Engineering Building**

**200 Madison Avenue • New York 16, N. Y.**

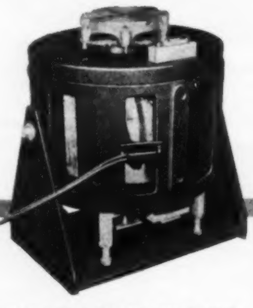
**ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS**

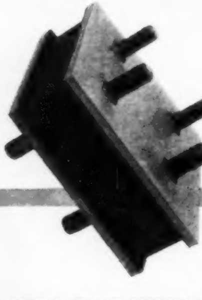
# How MB can help you MEET MILITARY SPECIFICATIONS ON VIBRATION

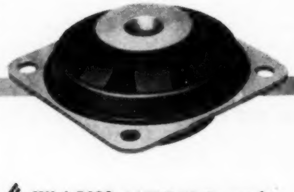



DOES YOUR MILITARY PRODUCTION require vibration *testing?* Shock *absorption*—vibration *isolation?* Representative of MB's specialized vibration engineering, these products show that, from a single source, you can get the equipment and information you need to meet your requirements. For example:

*1.* **MEASUREMENT** of vibration with MB vibration pickup and meter supplies data for study of disturbing frequencies and for design adjustments. The electrically damped and highly sensitive pickup is convertible for horizontal or vertical operation. Meter gives you accelerations, velocities or displacements of the vibrations directly. Made for each other, the two are the "eyes" for any vibration testing program.







*2.* **SHAKE TESTING TO MIL-E-5272 and 41065-B** is easily accomplished with MB Vibration Exciters. Model S-3 shown delivers 200-lb force. Others available with 10-lbs to 2500-lbs force ratings—all easily, quickly and accurately controlled for force and frequency.

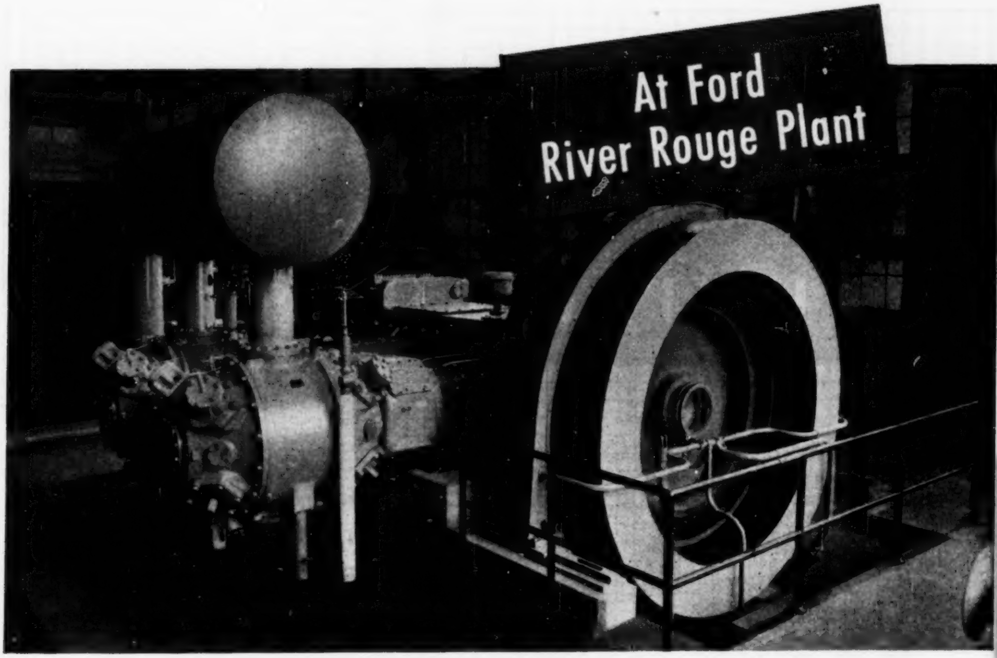
*3.* **ISOMODE* SHOCK MOUNTS** have been developed for supporting and protecting aircraft engines from damage while transported in crates or "cans." High load capacity combined with high deflection capacity provides good absorption of shock. **Reg. U.S. Pat. Off.*

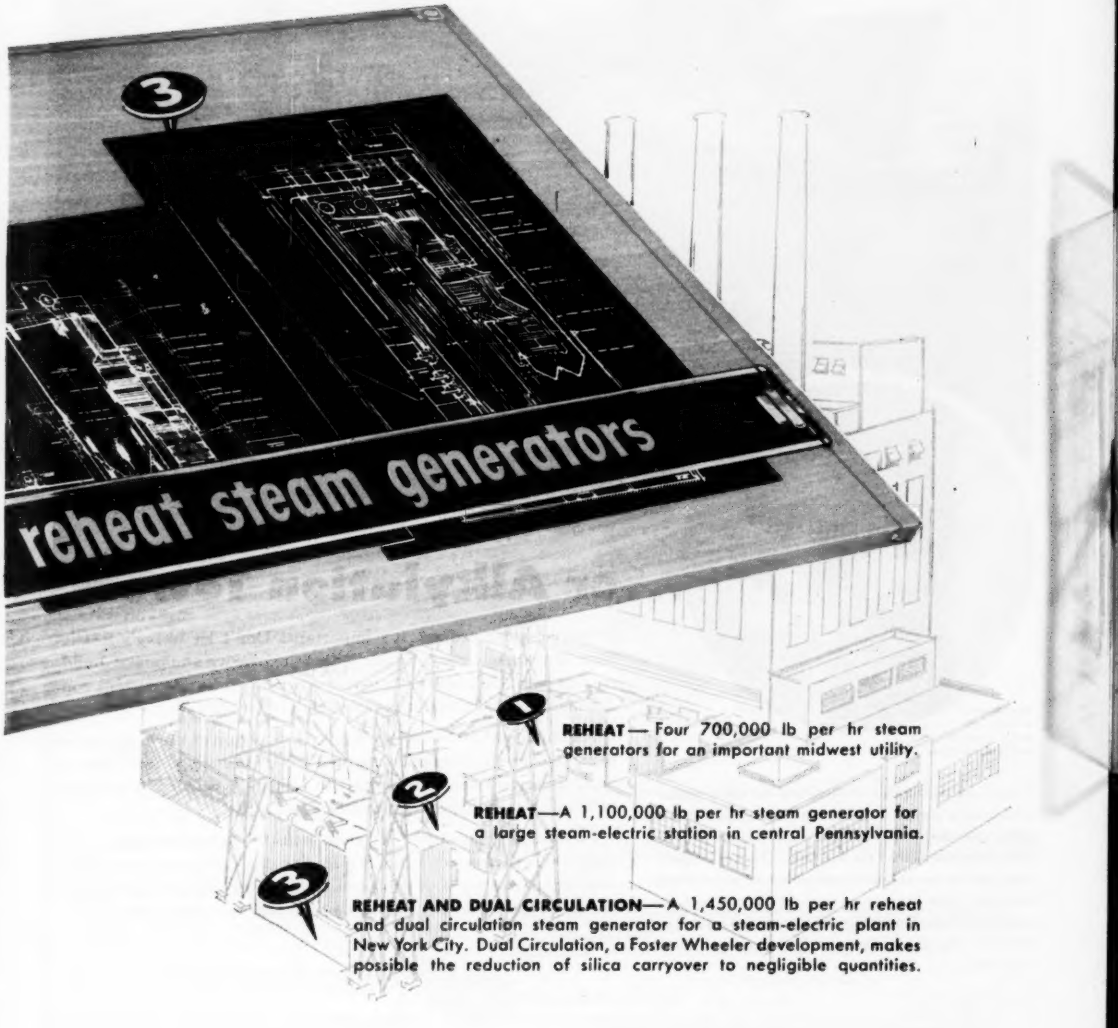
*4.* **MIL-I-5432** (AN-I-16a) can be met with the Type 17 ISOMODE Mount. This unit available for loads from 0.5 to 100 pounds, and controls all modes of vibration with equal efficiency because of equal spring rate in all directions.

Remember, if you need help with a vibration problem, you can save yourself time and work by contacting MB's vibration specialists. For details on any of the above products, address your inquiry to Dept. N4.

**THE MB MANUFACTURING COMPANY, Inc.**
1060 State St., New Haven 11, Conn.

PRODUCTS FOR MEASUREMENT . . . REPRODUCTION . . . AND CONTROL OF VIBRATION


At Ford
River Rouge Plant




1 **REHEAT**— Four 700,000 lb per hr steam generators for an important midwest utility.

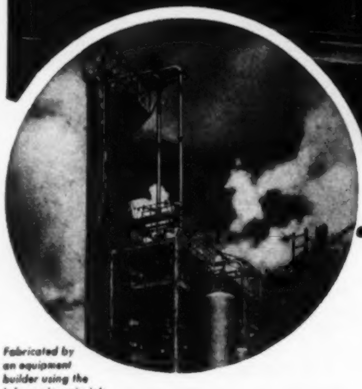
2 **REHEAT**—A 1,100,000 lb per hr steam generator for a large steam-electric station in central Pennsylvania.

3 **REHEAT AND DUAL CIRCULATION**— A 1,450,000 lb per hr reheat and dual circulation steam generator for a steam-electric plant in New York City. Dual Circulation, a Foster Wheeler development, makes possible the reduction of silica carryover to negligible quantities.

CORPORATION • 165 BROADWAY, NEW YORK 6, N. Y.

# FOSTER FW WHEELER

# Ore Carriers ...



*Fabricated by an equipment builder using the Lukenomics principle*

# ...or Alkylation Towers

Project records on this alkylation tower tell a typical Lukenomics story . . . excellent performance, lower costs, simplified construction. The problems presented were solved so well by the equipment builder's experience and his use of Lukens specialty steel plate, heads and steel plate shapes that seven similar towers have since been built. Particularly important now—the long life built into the equipment helps conserve strategic materials.

Whatever your project, it's important! Don't let today's restrictions kidnap efficiency. That's where progressive equipment builders can help. Delivering improved production, despite current conditions, is one of their prime contributions.

An important factor in this is their application of the Lukenomics principle. For Lukenomics combines their experience and that of leading designers and engineers with Lukens' specialized knowledge of materials, their production and application.

Get this *extra* attention for your project. We'll gladly put you in touch with equipment builders applying the Lukenomics principle. Just write, stating your problem, to Manager, Marketing Service, Lukens Steel Company, 513 Lukens Building, Coatesville, Pa.

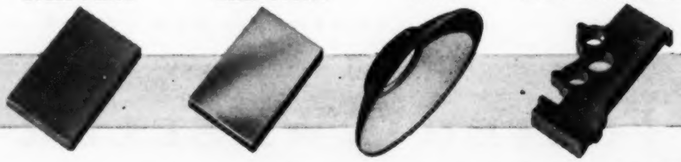
SPEED SALE OF YOUR SCRAP

LUKENS

LUKENS STEEL COMPANY

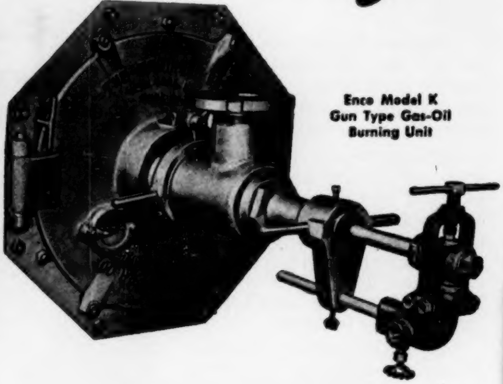
OVER 140 YEARS' EXPERIENCE AS THE WORLD'S LEADING PRODUCER OF SPECIALTY STEEL PRODUCTS

STEEL PLATE — CLAD STEELS — HEADS — STEEL PLATE SHAPES



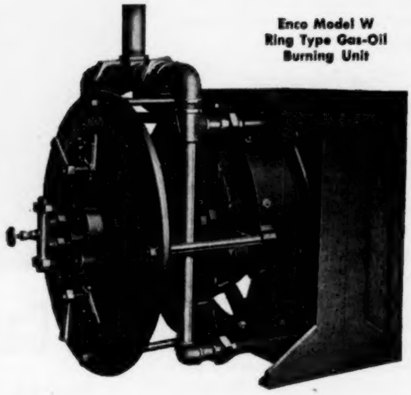
# *flexible... 3 ways*

# ENCO
## OIL AND GAS BURNER UNITS



Enco Model K
Gun Type Gas-Oil
Burning Unit

These specially designed oil and gas burner units fit your needs . . . even when your operating conditions keep changing. Enco Oil and Gas Burner Units offer money-saving flexibility on three important counts. (1) They are designed for use with either oil or gas — or both . (2) They assure completely uniform combustion and greater fuel economy though steam demands swing sharply. (3) They can be operated by either natural or forced draft.



Enco Model W
Ring Type Gas-Oil
Burning Unit

Even if your old combustion equipment "works", it pays to investigate the fuel-saving economies and full flexibility of these highly efficient units. Enco Burner Units are made in many sizes to suit all capacity requirements. Bulletin on request.

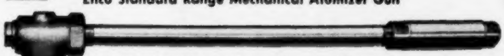
### ENCO
### INTERCHANGEABLE ATOMIZERS
#### FOR USE WITH ALL TYPES OF BURNER EQUIPMENT

Wide Range Mechanical—Manual or automatic control. Constant high oil pressure at atomizer insures efficient atomization over entire load range without recirculating or returning oil.

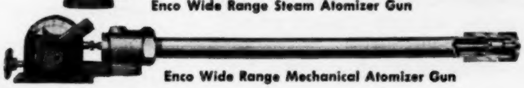
Steam or Air—Wide range. Controlled by manual or automatic pressure regulation.

Standard Range Mechanical — Available in all sizes to suit load and capacity requirements.

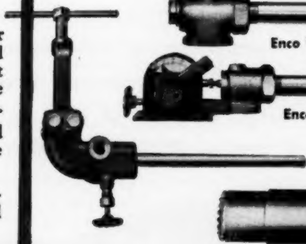
Enco Standard Range Mechanical Atomizer Gun



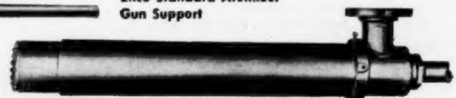
Enco Wide Range Steam Atomizer Gun



Enco Wide Range Mechanical Atomizer Gun



Enco Standard Atomizer
Gun Support



Enco Gas Burning Gun

EC-483

**THE ENGINEER COMPANY** 75 WEST STREET, NEW YORK 6, NEW YORK

IN CANADA: F. J. RASKIN, LTD., 4220 IBERVILLE ST., MONTREAL 34 P.Q.

## A Lot of Dependability in a Small Package

Thousands of industrial firms recognize the Cuno AUTO-KLEAN disc-type strainer as an indication of *protection* on lube and hydraulic systems.

They know the machine builder has provided the best means of keeping fluids *clean* . . . when he has installed the AUTO-KLEAN as standard equipment.

They appreciate, too, the ease with which the AUTO-KLEAN works. A turn of a handle—periodically by hand or continuously by automatic means—is all that is necessary to keep the strainer *itself* clean. This is done without stopping flow. And there's nothing to replace or renew.

They also know that the AUTO-KLEAN is *guaranteed* to remove 100% of the solids larger than specified*. . . with minimum pressure drop.

## The Favorite of Designers

The Cuno AUTO-KLEAN solves other problems *right on the board.*

It's compact. A single unit handling full flow (from a few to more than 4000 gpm) occupies no more space than the usual partial-flow type.

You can build it in—or mount it externally. Inlet and outlet can be in any position. You can install it on low pressure or gravity feed or suction with no loss of efficiency.

And you can depend upon it lasting as long as the equipment on which it is installed because it is all-metal and non-collapsible and can be made of a wide range of materials for various fluids, viscosities, temperatures and solids to be handled.

*Available spacings from .0035 in. to .062 in.

Cuno Engineering Corporation
Dept. 651 A, South Vine St., Meriden, Conn.
Please send information on Cuno AUTO-KLEAN
for ..............................
Name..............................
Company..............................
Address..............................
City................Zone....State....
Please attach to business letterhead

# You Can Clean This Fluid Strainer Without Stopping the Flow

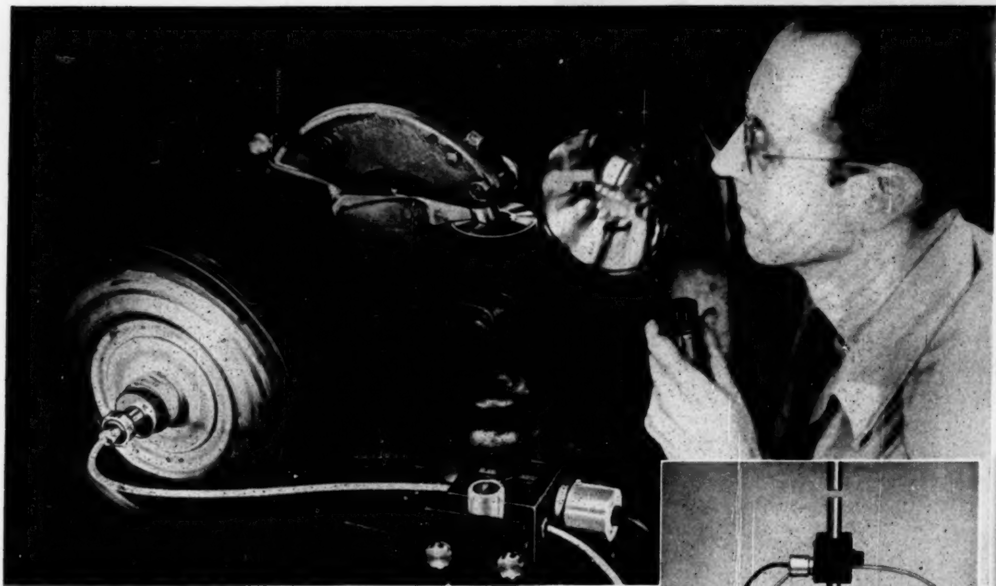
Cuno AUTO-KLEAN is the *only* fluid strainer with "comb-action cleaning" which permits it to work uninterruptedly. Dirt accumulations are dislodged *while* the straining goes on. This can be done automatically. *Guaranteed* to remove 100% of all solids larger than specified.

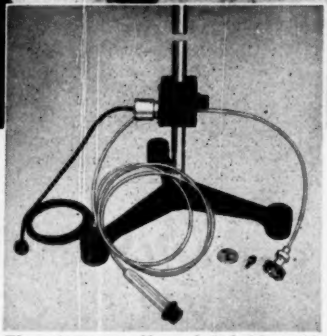
CUNO

*Fluid Conditioning*

**Removes More Sizes of Solids from More Kinds of Fluids**

**Strain** fuels, lubricants, process fluids, etc.—AUTO-KLEAN
**Filter** fuels, lubricants, process fluids, etc.—MICRO-KLEAN
**Clean** raw water, recirculating water, etc.—FLO-KLEAN





*The contactor assembly can be locked in position at any point on a 4-foot upright mounted on a heavy cast-iron base. The range of height adjustment is 6 inches to 4 feet; or the assembly can be removed from the stand and mounted permanently on a machine.*

**Type 1535-A Contactor** ..................... **$140.00**
**Type 1535-P1 Adaptor Cable**
*for use with the STROBOTAC* ........... **$5.50**

# *new* Synchronizing Contactor
## for the **STROBOTAC®** and the **STROBOLUME**

To meet an insistent demand from users of the General Radio stroboscopes for a versatile contactor, by means of which the STROBOTAC or STROBOLUME can be 'fired' from a mechanical contact with any rotating shaft, we announce the new Type 1535-A CONTACTOR.

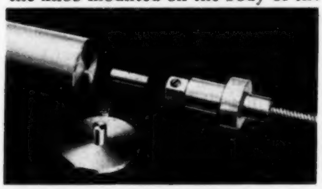
This unit has a powerful magnetic clutch, on the end of an 18-inch flexible shaft, which can be attached to any shaft of magnetic-sensitive material, even while the shaft is rotating.

The rotating clutch in turn drives an electrical contactor in the housing of the assembly. The contactor automatically synchronizes with the rotating shaft. Irrespective of changes in speed, the stroboscope is always in synchronization with the rotating shaft.

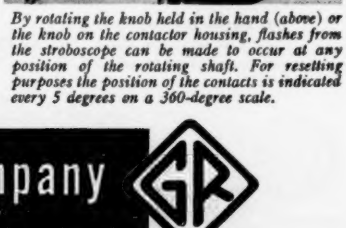
Flashes can be timed to occur at any position of the shaft, by either rotating a hand-held knob on the end of an 8-foot flexible cable, or by turning the knob mounted on the body of the contactor. The angular position of the contacts can be set anywhere within 360 degrees, the positioning scale being calibrated every 5 degrees to facilitate resetting.

There are six equally spaced contacts in the assembly. They can be connected to give combinations of 1, 2, 3 or 6 equally spaced flashes per shaft revolution.

This magnetic contactor greatly increases the utility of General Radio stroboscopes in industry, providing a simple, reliable and accurate means for timing the stroboscopic flashes to synchronize automatically with any rotating shaft.



*The accessories shown above are supplied with the Contactor. The steel disc in the foreground is used when the magnetic clutch is to be attached to non-magnetic or small shafts. The short rod can be fitted into a hole drilled in the shaft so that the screw-set coupling can be attached to the shaft for permanent or semi-permanent set-ups.*



*By rotating the knob held in the hand (above) or the knob on the contactor housing, flashes from the stroboscope can be made to occur at any position of the rotating shaft. For resetting purposes the position of the contacts is indicated every 5 degrees on a 360-degree scale.*

**GENERAL RADIO Company**

275 Massachusetts Avenue, Cambridge 39, Mass.

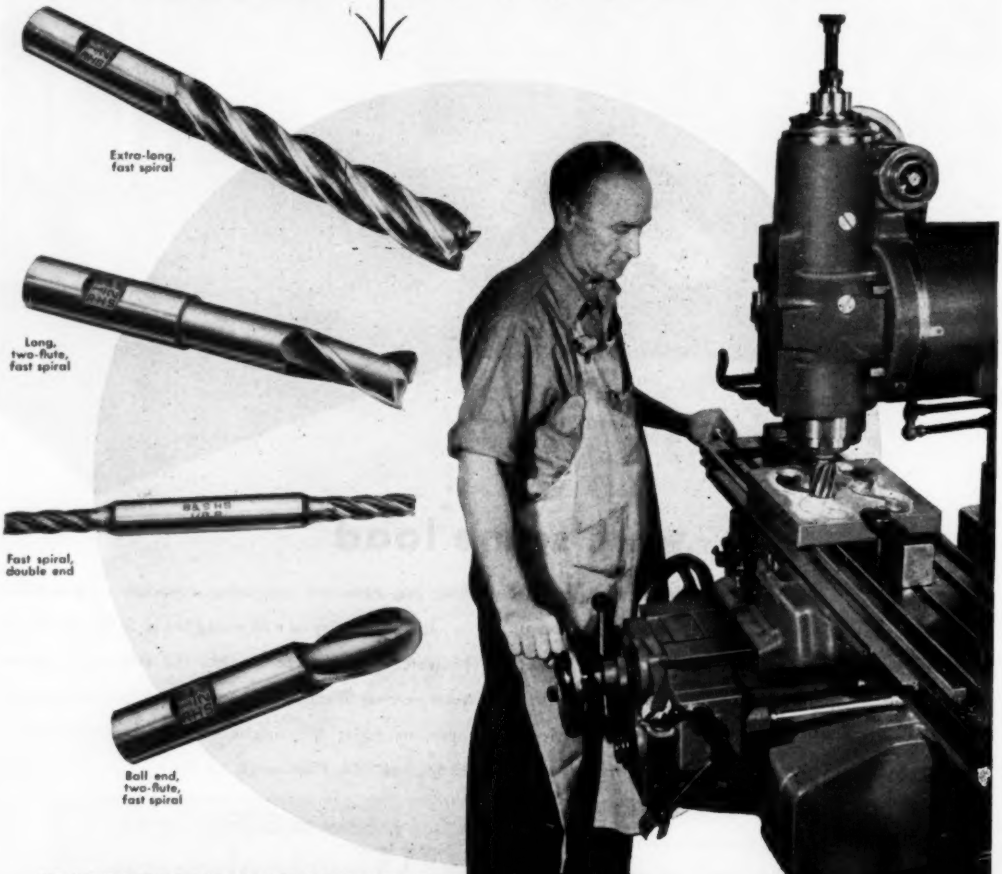
90 West Street NEW YORK 6 · 920 S. Michigan Ave. CHICAGO 5 · 1000 N. Seward St. LOS ANGELES 38

# End Mills that Save Down-Time

Precision-made end mills that meet the highest standards of cutter design have advantages especially important in fulfilling today's high production requirements. They cut faster, more freely, and with less power. Their greater wearing qualities enable them to turn out more work between sharpenings — reduce machine down-time.

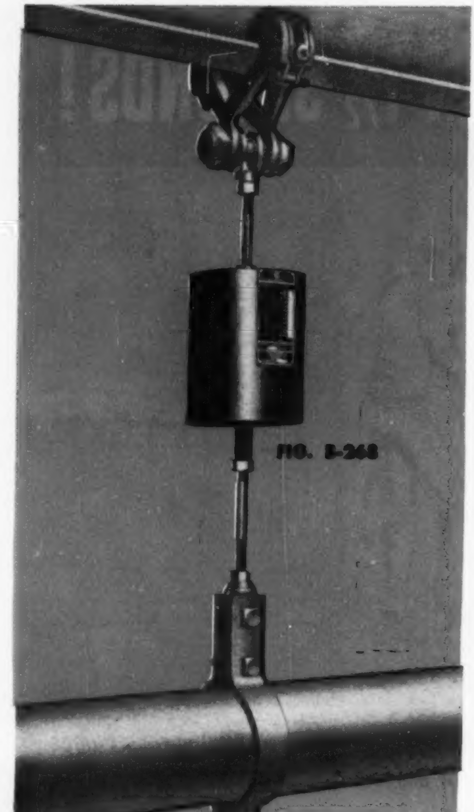
Brown & Sharpe End Mills are made under exacting quality control, from start to finish. In both steel formula and heat treatment, they are closely held to rigid specifications. Careful machining maintains consistent adherence to design standards.

To assure maximum productivity from your milling machines, specify end mills and other cutters from the complete Brown & Sharpe line. Write for Catalog.
Brown & Sharpe Mfg. Co., Providence 1, R. I., U.S.A.




**WE URGE BUYING THROUGH THE DISTRIBUTOR**

**Brown & Sharpe** BS



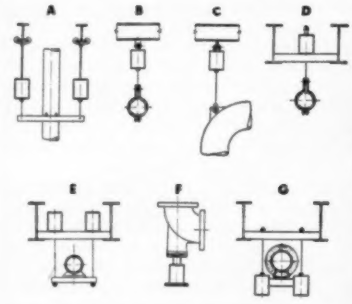

# Pre-solve Pipe Suspension Problems...

***with* Grinnell Pre-engineered Spring Hangers**

- Maximum variation in supporting force per ½" of deflection is 10½% of rated capacity — in all sizes.
- Precompression* assures operation of spring within its proper working range where variation in supporting force is at a minimum.
- Compact—minimum headroom made possible by precompression*.
- Guides prevent contact of coils with casing wall or hanger rod and assure continuous alignment and concentric loading of spring.
- All-steel welded construction meets pressure piping code.
- 16 sizes available from stock — load range from 74 lbs. to 9000 lbs.
- Easy selection of proper sizes from simple capacity table.
- Installation is simplified by integral load scale and travel indicators.
- Unique swivel coupling provides adjustment and eliminates turnbuckle.

**Precompression is a patented feature.*

**TYPICAL APPLICATIONS**

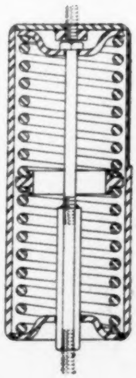



(A) Rod threaded to top cap (B) Furnished with single lug (C) Two lug style (D) Top adjusting (E) Adjustable top and bottom (F) For floor support (G) Trapeze assembly.

**FOR LESS VARIATION IN SUPPORTING FORCE — FIG. 98**

Fig. 98 is an adaptation of Grinnell's popular spring hanger, Fig. 268. It consists of two springs arranged in series within a single casing. A centering guide insures the permanent alignment of the spring assembly.

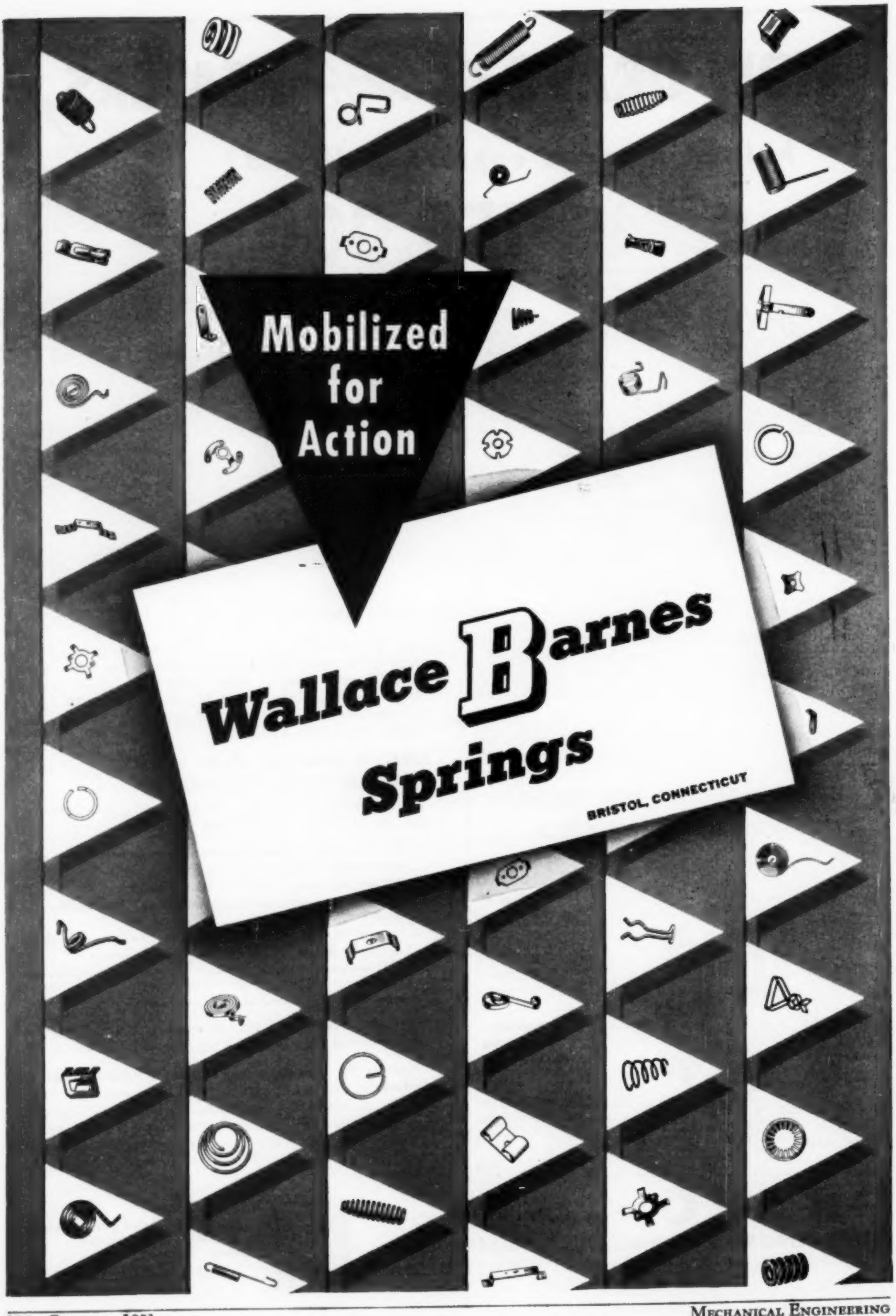
Fig. 98 has half the load deflection rate, and double the total working range of Fig. 268. Its 16 spring sizes accommodate loads from 74 lbs. to 9000 lbs. — but with a total working range *up to 5 inches!* Fig. 98 comes in the same seven types as shown for Fig. 268. Design details for identical types and sizes are the same for Fig. 98 and Fig. 268.



**GRINNELL**

**WHENEVER PIPING IS INVOLVED**

GRINNELL COMPANY, INC., Providence, R. I. Warehouses: Atlanta • Billings • Buffalo • Charlotte • Chicago • Cleveland • Cranston • Fresno • Kansas City • Houston • Long Beach • Los Angeles • Milwaukee • Minneapolis • New York • Oakland • Philadelphia • Pocatello • Sacramento • St. Louis • St. Paul • San Francisco • Seattle • Spokane


Mobilized
for
Action
Wallace Barnes
Springs
BRISTOL, CONNECTICUT

# AT ROCKFORD

**CENTRAL ILLINOIS**
**ELECTRIC AND GAS CO.**
**Rockford, Illinois**

*It's Detroit Rotograte*

*Detroit RotoGrate Stoker ready for shipment to Sabrooke Station.*

# FOUR CONTRACTS FOR TWO STATIONS

**Stone & Webster**
**Engineering Corporation**
*Engineers and Constructors*

*960,000 Pounds of Steam per Hour total Capacity*

**Write for complete information on Detroit RotoGrate Stokers.**


"Well, for one thing, it leaks."

By permission. Copr. 1951, The New Yorker Magazine Inc.

# SPONGEX Stops Leaks...

## ...also noise, shock, dust, vibration and air.

This test driver reports his tank in need of a moisture-proof seal. *Spongex cellular rubber* will do the trick and keep *doing* the trick after endlessly repeated slammings... after oil has failed to soften it and temperatures fluctuating over a wide range have failed to stiffen it. It will be fire resistant and have excellent aging properties. It will meet Federal Specifications MIL-C-3133 & MIL-R-6130.

This tank might even be lined with *Spongex Plastic,* expanded polyvinyl chloride yielding outstanding insulation value (0.20 to 0.25 K factor) and possessing excellent crash pad properties. Also oil and fire resistant.

SPONGEX PRODUCTS

*The world's largest specialist in the manufacture of cellular rubber.*

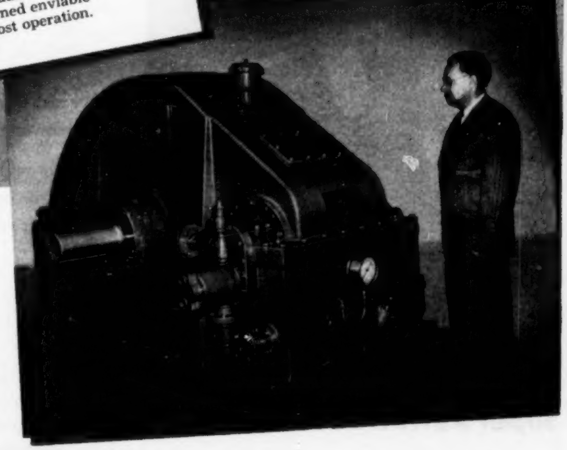
**THE SPONGE RUBBER PRODUCTS CO.** • 401 Derby Place, Shelton, Conn.

**STRIPS • CORDS • TUBING • SHEETS • MOLDED FORMS • DIE-CUT SHAPES**


The photography was bad but the engineering was good on this Pacific-Western high-speed unit. It is still (in 1951) doing its job efficiently—operating a high-speed blower. For several decades Pacific-Western high-speed units have earned enviable reputations for reliable, low-cost operation.

**16 YEARS LATER**

Same company, same engineer—with one of the newest Pacific-Western high-speed units, a smooth, efficient design—and above all, *dependable*. This speed increaser was built to drive a large pump.



***Gearmakers to Industry***

For standard or special high-speed units or speed reducers of all kinds . . . for any type of gearing or geared product used in industry, take advantage of our experience (more than fifty years) and facilities (four manufacturing plants) comprising the Pacific-Western organization. Our nearest Pacific-Western plant or sales office will be glad to give you prompt service on your inquiry.

5114A

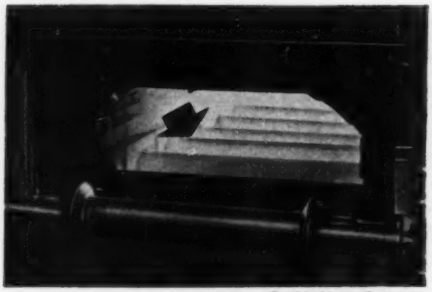
**WESTERN GEAR WORKS**
Manufacturers of PACIFIC-WESTERN Gear Products
**Pacific Gear & Tool Works**

Plants: Seattle, San Francisco, Lynwood, Houston
Representatives: Portland, Denver, Vancouver, B.C.

***Plants*** • 417 Ninth Ave. S., Seattle 4, Wash.
2600 E. Imperial Highway, Lynwood, Los Angeles County, California
1035 Folsom St., San Francisco 3, Calif.
117 N. Palmer St., Houston, Texas

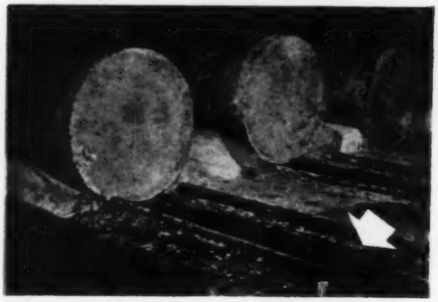
***Representatives*** • 930 S.E. Oak St., Portland 14, Oregon
Room 211, Chamber of Commerce Bldg., Denver, Colorado
Engineering & Machinery Ltd., 1366 W. Broadway, Vancouver, B.C.

# CAUGHT for heat



*Gas Machinery Company*

**HEAT?** Instead of using metal rollers, the manufacturer of this annealing furnace applied a Super Refractory roller-hearth. As a result, the hearth stays straighter, lasts longer, and reduces marking and pick-up.



**ABRASION?** The skid rails supporting these brass billets were formerly made of alloy. The alloy skids required complete replacement every two to five weeks, constant maintenance between times. When replaced with Super Refractory skids, the new rails required no attention for over three years.

**CORROSION?** An interesting application of Super Refractories where no heat is involved is this wire guide. It supports newly drawn steel wire as it passes along the bottom of a tank during zinc coating. It seems to be the only material that will stand up at all under the cutting action of the wire and the corrosive action of the plating solution.

Here's a group of materials often used in place of certain metals—Super Refractories by CARBORUNDUM. Possessing properties seldom associated with refractories, these materials have often proved superior to the metals they replaced; have been invaluable where critical nickel, chrome, or cobalt alloys were involved.

For example, Super Refractories have replaced metals for such diverse applications as: skid rails, muffles, wire guides, radiant tubes, roller hearths, hot blast mains, brazing fixtures, recuperator tubes, etc. In these cases, they not only *released* vitally needed metals but *outperformed* them (by lasting longer than the metals — while also increasing the capacity of the equipment).

As you look over the properties of Super Refractories listed opposite, draw a mental comparison with your needs. Exactly what makes an alloy essential in this place, or that? Is it refractoriness? conductivity? abrasion? corrosion? strength? It's surprising how often you'll find Super Refractories inherently better — and far less expensive — than metals.

It will pay you to investigate these interesting Super Refractories . . . *now*, before the metals cupboard is bare. Won't you write or call us today?

***Super Refractories by***

## CARBORUNDUM

TRADE MARK

Refractories Division

The Carborundum Company, Perth Amboy, N. J.

*"Carborundum" is a trademark indicating manufacture by The Carborundum Company*

# IN THE SQUEEZE resisting metals?

## SUPER REFRACTORIES ARE IDEAL WHERE

**HIGH HEAT IS INVOLVED.** Super Refractories are very strong and durable—can be safely used at temperatures over 3000 F. Compare this with 25-12 chrome-nickel steel, for example, which loses strength rapidly over 1500 F. and cannot be used with safety above approximately 2100 F.

**ABRASION OR EROSION ARE PRESENT.** Two types of Super Refractories are within one index point of diamond hardness! They are the toughest known materials for large scale commercial use. They will distinctly outwear metals—especially at furnace temperatures.

**HEAT CONDUCTIVITY IS NEEDED.** At elevated temperatures, one Super Refractory material conducts heat *almost as rapidly as chrome-nickel steels.* It's widely used in equipment involving heat transfer. There are also Super Refractories which are good insulators, particularly at high heats.

**STRENGTH IS IMPORTANT.** Super Refractories are generally very strong, and *retain* their strength at temperatures where metals become unusable. For example, the modulus of rupture of one composition averages 3100 psi, at 2460 F. No commercial tonnage refractories have greater strength.

**CHEMICAL ACTION IS PRESENT.** In general, most Super Refractories are either neutral or acid in nature—are widely used where chemical inertness is important.

**SPECIAL SHAPES ARE INDICATED.** Practically all Super Refractories are available in a wide variety of construction shapes molded to close tolerances—including fitted joints, tubes, etc.


**USE THIS BOOKLET TO CHECK UP.** This new booklet contains an easy-to-read analysis of the principal characteristics of these unique Super Refractories. The coupon will bring you the story—or one of our engineers will be happy to talk over your problems. We believe it could be mutually profitable.

**Dept. P-101**
**Refractories Div., The Carborundum Co.**
**Perth Amboy, New Jersey**

Please send me your free booklet on the properties of Super Refractories.

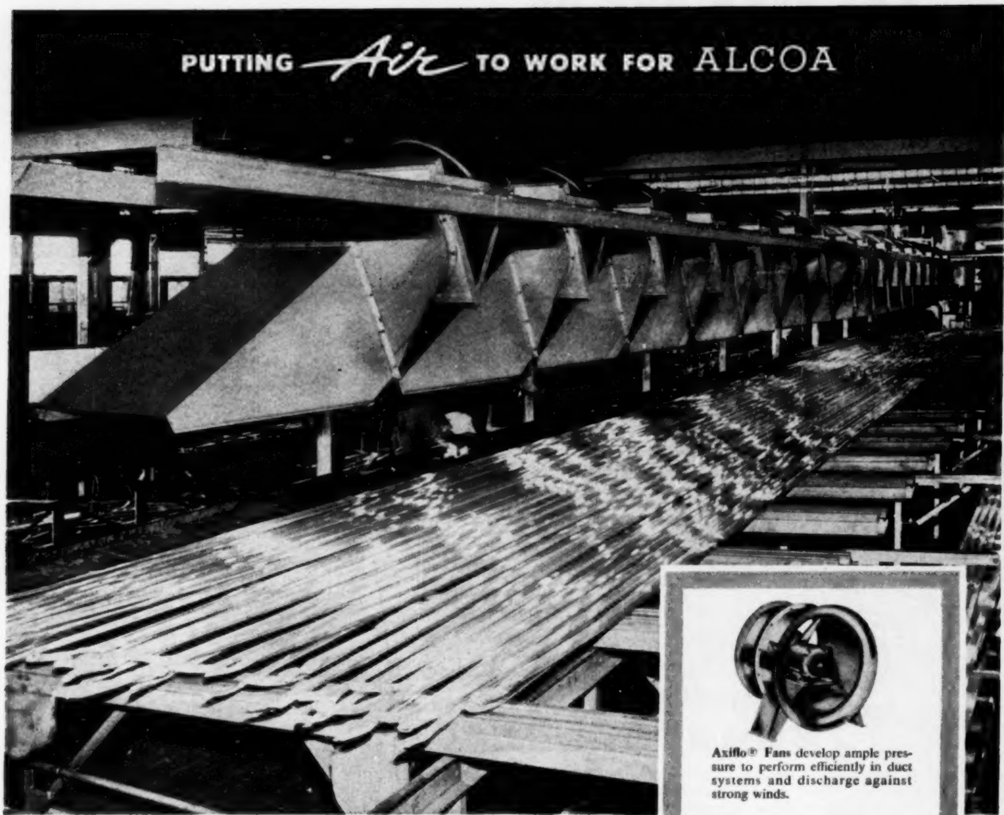
Name__________

Position__________

Company__________

Street__________

City______ Zone____ State____




Axiflo® Fans develop ample pressure to perform efficiently in duct systems and discharge against strong winds.

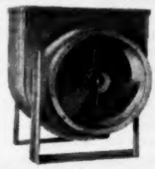
# BIG BREEZE

## SOAKS UP 300° IN A HURRY

These 100-foot strips of structural aluminum are getting an air bath that sponges off 300° F. . . . but fast. A concentrated blast of air quenches the hot shapes leaving the forming mold . . . cools continuously for over 100 feet as they move down the line.

Mounted overhead are 17 Sturtevant Axial Flow Fans, delivering quenching air that helps maintain mechanical properties in the aluminum through quick, even cooling. These large capacity fans supply a steady stream of cooling air at high efficiency. Result: a uniform product for ALCOA.

There's Westinghouse equipment ready to help you *put air to work* too . . . whether it's with air handling, air conditioning, or electronic air cleaning. Call your local Westinghouse-Sturtevant office for full details, or write Westinghouse Electric Corporation, Sturtevant Division, Hyde Park, Boston 36, Massachusetts.



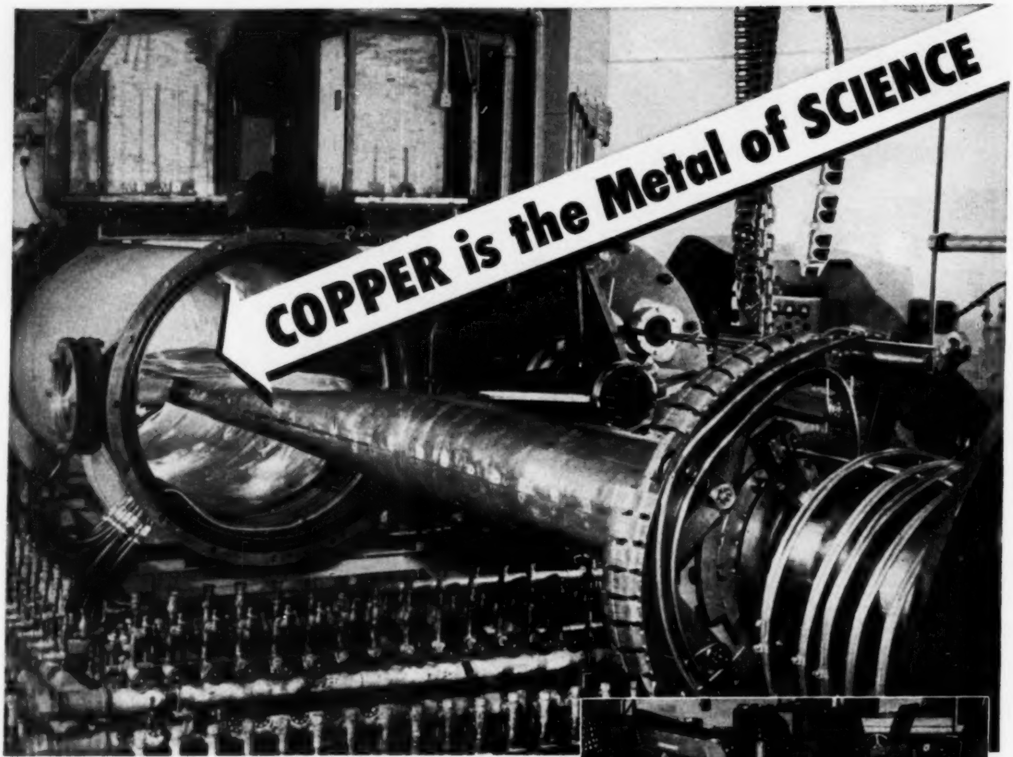
In Elbow Axiflo Fans, motors, belts and bearings are located outside the air stream, an advantage in handling corrosive fumes.

Silentvane® Centrifugal General Purpose Fans move air efficiently and quietly for many industrial and commercial applications.

**YOU CAN BE SURE...IF IT'S**

**Westinghouse**

J-80226




*D and D Stem being inserted in Cyclotron; made of Revere Electrolytic high-conductivity copper, hot rolled and annealed, ⅛" thick. Note also large number of bronze valves to control flow of cooling water through brass pipe.*

● For many years Revere has been saying that "Copper is the metal of invention." It has high electrical and heat conductivity, excellent resistance to corrosion, is easily fabricated and formed, so that it is attractive to designers and inventors, as well as to manufacturers. Now we say it is also "The metal of science," because it is so essential to the operation of most scientific devices.

The pictures on this page illustrate some of its uses in a cyclotron, built by and for the Nuclear Physics Laboratory of the University of Washington in Seattle. The instrument was designed and constructed so far as possible by University personnel, who were completely successful in working copper into the most complicated shapes.

Revere collaborated on the project in various ways, and furnished copper bar, sheet, rod and tube to the University's high specifications. Remember that Revere will be glad to consult with you on your problems concerning copper and copper alloys, and aluminum alloys.

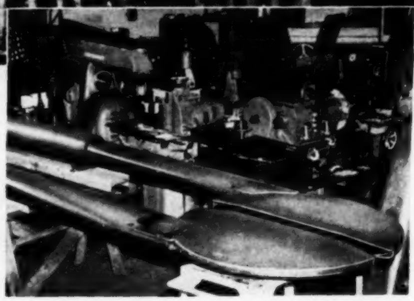
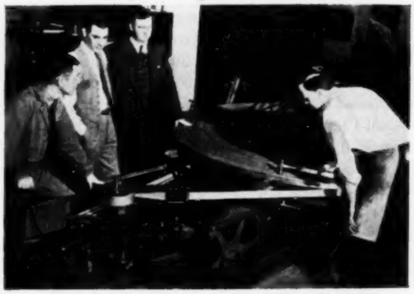


*Photo taken in the University of Washington shop during fabrication of the two Ds and D Stems.*



*Seven miles of Revere copper bus bar were wound into great coils for the cyclotron electromagnet. The University built the winding machine itself, and wound the coils in its own shop. The special Revere bar is soft temper, free from scale, with rounded edges.*

**REVERE** 150th YEAR OF SERVICE TO AMERICA

**COPPER AND BRASS INCORPORATED**

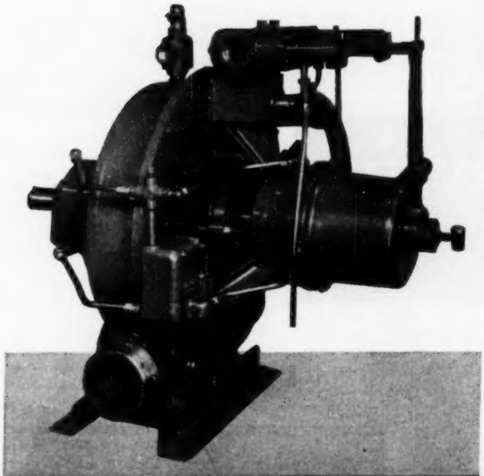
*Founded by Paul Revere in 1801*

230 Park Avenue, New York 17, N. Y.

• • •

*Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y. — Sales Offices in Principal Cities, Distributors Everywhere*

SEE "MEET THE PRESS" ON NBC TELEVISION EVERY SUNDAY



# Wing

**AUXILIARY**

# TURBINES

WING TURBINES are especially economical for driving pumps, fans, compressors, etc., in plants using steam in process operations. The turbines act as reducing valves on boiler steam pressure, the power which drives the turbines, therefore, being practically free.

Wing Turbines for over half-a-century have been noted for their rugged construction, trouble-free operation and long life.

Maximum BHp 150. Maximum Steam Temperature 750 F. Maximum Pressure 600 lbs. Back Pressure to 50 lbs. Speeds to 4000 rpm.

**L. J. Wing Mfg. Co.**
**Linden, N. J.**
*Offices in principal cities*

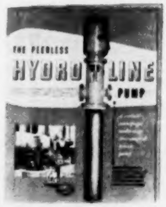
# DO YOU HAVE THE LATEST INFORMATION ON PEERLESS PUMPS?

PEERLESS PUMPS

***MAIL COUPON FOR FREE ENGINEERING BULLETINS***
...describing and illustrating GENERAL PURPOSE PUMPS, FIRE PUMPS, PROCESS PUMPS and MECHANICAL SHAFT SEALS.

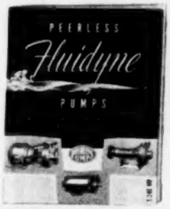

**DESCRIBES TYPE A GENERAL PURPOSE PUMPS** from $1\frac{1}{4}$" to 48" in size with capacities to 70,000 gpm.


**DESCRIBES HORIZONTAL FIRE PUMPS**—Underwriters' Approved (Dayton-Dowd design) single and multi-stage types and auxiliary equipment.




**DESCRIBES ENCASED CLOSE-COUPLED VERTICAL CENTRIFUGAL PROCESS PUMP** for pumping light hydrocarbons and chemicals where NPSH is limited and floor space is at premium.


**DESCRIBES MECHANICAL SHAFT SEALS** for preventing leaks along rotating shafts; for shaft sizes to 5 inches in diameter.




**DESCRIBES THE PEERLESS FLUIDYNE LINE** — one of the broadest ranges of end-suction pumps offered; up to 150 hp.

**CHECK, CLIP AND MAIL COUPON TODAY**

**PEERLESS PUMP DIVISION**
***FOOD MACHINERY AND CHEMICAL CORPORATION***
Los Angeles 31, California

Please send the Bulletins checked below:

☐ TYPE A PUMP ☐ VERTICAL PROCESS PUMP
☐ FIRE PUMPS ☐ FLUIDYNE PUMPS
☐ MECHANICAL SHAFT SEALS

NAME ____________________
COMPANY ____________________
ADDRESS ____________________
CITY ____________________ STATE ________

**MECHANICAL ENGINEERING**

**September, 1951 — CARD INDEX — Vol. 73, No. 9**


FOR THE MEN WHO SELECT COUPLINGS FOR PERFORMANCE...

# LOVEJOY FLEXIBLE COUPLINGS

Through the years, Lovejoy Flexible Couplings have been giving outstanding performances. They feature free-floating load cushions which are suspended between heavy metal jaws. There is no metal-to-metal power transmission and less wear on bearings and shafts. They instantly, permanently correct for angular, parallel or combination angular parallel misalignment. They also absorb vibration, shock, backlash and surge. Cushions are available for every duty . . . 1/6 to 25000 h.p. and last two to five years before changing. For the best in coupling performance, use Lovejoy Flexible Couplings.

★ SEND FOR COMPLETE LOVEJOY CATALOG AND QUICK-FINDING SELECTOR CHARTS

**LOVEJOY FLEXIBLE COUPLING CO.**

5032 W. Lake Street, Chicago 44, Illinois

*Also Mfg. Lovejoy Universal Joints and Lovejoy Variable Speed Transmissions*

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# IT CALLS FOR

# OPEN STEEL FLOORING

If you are planning a new building, or of modernizing old walking surfaces indoors or out, look into the advantages of open steel flooring . . . the versatile flooring . . . now! New catalog illustrates and describes wide range of modern applications, its safety features, strength, simplicity of installation and maintenance. Send for a copy.


**NEW FREE IDEA-BOOK**

**write today**

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HENDRICK MANUFACTURING CO. Carbondale, Pa.
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STANDARD STEEL SPRING CO. Gary, Indiana
WALTER BATES CO., INC. Joliet, Illinois
THE TRI-LOK COMPANY Pittsburgh, Pa.
BLAW-KNOX COMPANY, Pittsburgh, Pa.

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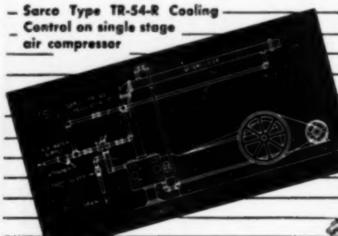
— Sarco Type TR-54-R Cooling Control on single stage air compressor




# efficient COMPRESSOR COOLING

- Do you want to avoid over — or under — cooling?
- Do you want to save cooling water and lubricants?
- Do you want to increase the efficiency and life of your air compressor? . . . then install SARCO COOLING CONTROLS

Simple • Self-operated • Inexpensive

**Ask for Bulletin No. 701**

Sarco TR-54-R

**SARCO COMPANY, INC.**

EMPIRE STATE BUILDING, NEW YORK 1, N.Y.

Represented in Principal Cities
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518

Representatives—Sales Agencies
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# OPPORTUNITIES

Positions Open—Positions Wanted—Equipment, Material, Patents, Books, Instruments, etc. Wanted and For Sale

*Answers to box number advertisements should be addressed to given box number, care of "Mechanical Engineering," 29 West 39th St., New York 18, N. Y.*

## POSITIONS OPEN

### ENGINEER

Experienced engineer to design and develop domestic heating and air conditioning equipment. Must have design and development experience in either gas fired furnaces and boilers or in air conditioning equipment or in oil fired furnaces, boilers and oil burners.

Position requires initiative and ability to develop competitive equipment.

Write complete qualifications in first letter, including present compensation and salary expected. If possible include recent snapshot which will not be returned.

All replies will be treated in absolute confidence.

Address CA-3657, % "Mechanical Engineering."

**RATES** Classified Advertisements under this heading in MECHANICAL ENGINEERING are inserted at the rate of $1.70 a line. $1.35 a line to members of ASME. Seven words to the line average. A box number address counts as one line. Minimum insertion charge, 5 line basis. Display Advertisements carried in single column units of multiples of one inch at flat rate of $28 per inch per insertion. Copy must reach us not later than the 10th of the month preceding date of publication.

### WATCH ENGINEER

For large industrial plant in Maryland. Applicant should be under 40 years of age and possess a B.S. degree in Mechanical Engineering from an accredited college or have equivalent operating experience. He must be familiar with powdered coal and stoker-fired boilers. Salary open.

The Power Plant in which he will work has an approximate steaming capacity of 500,000 pounds per hour. About one-half of this capacity is utilized for electrical current generation, and the rest, including by-product steam from a turbine, is utilized for process requirements.

Address CA-3645, c/o "Mechanical Engineering."

### CONSTRUCTION ENGINEER
### DESIGN ENGINEER

Construction Engineer (mechanical or civil) for process plant. Experienced in heavy construction, including buildings, piping, and machinery installation.

Also, Design Engineer (mechanical or civil) for process industry. Familiar in heavy industry plant construction, including design, equipment specifications, and machinery installations.

These positions in a modern, expanding plant in northern Ohio River valley, Attractive insurance and pension plans, desirable community, excellent opportunities for competent men.

Address CA-3649, c/o "Mechanical Engineering."

Fire Protection
**ENGINEERING**
An expanding field with a top-flight organization.
**RECENT GRADUATES**
Wanted to train as fieldmen. Send personal resumé to:
CA-3648, c/o "Mechanical Engineering."

### PHYSICISTS AND SENIOR RESEARCH ENGINEERS

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## POSITIONS NOW OPEN

Senior Engineers and Physicists having outstanding academic background and experience in the fields of:

- Microwave Techniques
- Moving Target Indication
- Servomechanisms
- Applied Physics
- Gyroscopic Equipment
- Optical Equipment
- Computers
- Pulse Techniques
- Radar
- Fire Control
- Circuit Analysis
- Autopilot Design
- Applied Mathematics
- Electronic Subminiaturization
- Instrument Design
- Automatic Production Equipment
- Test Equipment
- Electronic Design
- Flight Test Instrumentation

are offered excellent working conditions and opportunities for advancement in our Aerophysics Laboratory. Salaries are commensurate with ability, experience and background. Send information as to age, education, experience and work preference to:

**NORTH AMERICAN AVIATION, INC.**
**AEROPHYSICS LABORATORY**

Box No. H-4
12214 South Lakewood Blvd.
Downey, California

## ATOMIC ENERGY INSTALLATION NEEDS ENGINEERS

**AERONAUTICAL** **MECHANICAL**

**AERODYNAMICISTS**

Two to ten years' experience in research, design, development or test. Patent history desirable but not necessary. A variety of positions open for men, with Bachelor's or advanced degree, qualified in one or more of the following fields:

- STRESS ANALYSIS
- AIR FRAME DESIGN
- SHOCK AND VIBRATION
- QUALITY CONTROL
- ELECTRONIC PACKAGING
- LARGE WIND TUNNEL TEST
- INSTRUMENTATION
- ENVIRONMENTAL TESTING
- MECHANISMS
- HANDLING EQUIPMENT

### STANDARDS ENGINEERS

Experienced in writing specifications, in liaison work, and in correlating design information to accepted standards. Aircraft industry experience desirable.

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THESE ARE PERMANENT POSITIONS with Sandia Corporation in Albuquerque, N. M. Sandia Laboratory is operated by the Sandia Corporation, a subsidiary of the Western Electric Company under contract with the ATOMIC ENERGY COMMISSION. This laboratory offers good working conditions and liberal employee benefits, including paid vacations, sick leave, and a retirement plan.

Albuquerque, center of a metropolitan area of 150,000, is located in the Rio Grande Valley, one mile above sea level. The "Heart of the Land of Enchantment," Albuquerque lies at the foot of the Sandia Mountains, which rise to 11,000 feet. Climate is sunny, mild and dry the year 'round.

**MAKE APPLICATION TO: PROFESSIONAL EMPLOYMENT DIVISION**

**SANDIA CORPORATION**
**SANDIA BASE, ALBUQUERQUE, NEW MEXICO**

It will pay you to read the announcements on these pages for an opportunity that you may be looking for or one that may be of interest to you.

# "OPPORTUNITIES" Section This Month . . . . . 126-133

## POSITIONS OPEN



*Continued on Page 133*

**RATES** One Inch Card Announcements Inserted at rate of $20.00 each issue. $15.00 per issue on yearly contract.

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Manufacturers of Equipment Not Included

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Consulting Engineers
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Consult **Z. H. POLACHEK**
Reg. Patent Attorney
1234 Broadway
(at 31st St.) New York 1, N. Y.
Phone LO 5-3088

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**EHRCO DIE CASTING SERVICE**
Die Casting Consultation
Equipment—Installation
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**WELD TESTING**
Qualification of Operators—Supervision
Inspection—Research
**NATIONAL WELD TESTING BUREAU**
Pittsburgh Testing Laboratory, Pittsburgh, Pa.

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**SANDERSON & PORTER**
ENGINEERS AND CONSTRUCTORS
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**C. M. HATHAWAY**
CONSULTING ENGINEER
Project Engineering, Product Development,
Production Designs, Laboratory and Shop
Facilities for Research, Model Work,
and Pilot Manufacturing
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**NUCLEAR DEVELOPMENT ASSOCIATES, Inc.**
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Consulting Physicists, Mathematicians, and Engineers. Studies in Analytical Engineering and Mathematical Physics
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WHite Plains 8-5800

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Appraisals, Reports
**SARGENT & LUNDY**
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**JACKSON & MORELAND**
ENGINEERS AND CONSULTANTS
Design and Supervision of Construction
Reports — Examinations — Appraisals
Machine Design — Technical Publications
Boston — New York

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**DELOS M. PALMER & ASSOCIATES**
CONSULTING ENGINEERS
Reg. Mechanical, Electrical & Industrial
Designers of Special Purpose Machines
Product Development
Laboratory and Model Work
4401 Jackman Rd. — Toledo 12, Ohio

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**J. E. SIRRINE COMPANY**
Engineers
Design and Supervision of Steam and Hydro-electric Power Plants, Industrial Plants, Mechanical and Operating Surveys, Appraisals • Plans • Reports
Greenville, South Carolina

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**GEORGE H. KENDALL**
***Consulting Mechanical Engineer***
Cost Reduction Studies: Process or Product.
Redesign Existing Products for Greater Profit.
Trouble Shooting Production, Design, Cost Problems.
Specialist Automatic Machinery Processes, Controls,
New Developments, Patent Studies, Investigations.
New Products & Process Engineering Studies.
P. O. Box 72 — (*Est. 1923*) — Tel. Darien 5-1504
Noroton Heights — Darien, Connecticut

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**Metallurgists**
**Analysts** — **Consultants**
**Spectroscopists**
**PHILADELPHIA TESTING LABORATORIES**
900 W. Venango Street
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**STANLEY ENGINEERING COMPANY**
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*Exploded Views -*
*"Tech" Manuals for Defense Contracts*
RESEARCH AND DEVELOPMENT
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*An announcement in this section will acquaint others with your specialized practice.*

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ST & CO. INC.
**DESIGNING ENGINEERING**
Machines • Products • Plants
Processes • Production • X-Ray
**SAM TOUR & CO., INC.**
44 TRINITY PL., N. Y. 6, N. Y.

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## "OPPORTUNITIES" Section . . . 126-133

*Continued from Page 132*

### PATENTS FOR SALE

PULVERIZER AND AIR CLASSIFYING SYSTEM PATENT. Including forty horsepower pulverizer and classifier, patterns and drawings. Outright sale or Royalty agreement. Will assist development if required. Address CA-3680, care of "Mechanical Engineering."

### BUSINESS OPPORTUNITIES

License or interest in U. S. Patent No. 2,460,813, "PLAN KING," Copyright, 1951, by C. Dohn. Typewriter machine for writing upon drawings. Substantial Market. Profit making opportunity. Exceptionally good for a progressive manufacturer of business machines. Write for details. Indicate interest. Address CA-3677, care of "Mechanical Engineering."

### EMPLOYMENT AGENCIES AND SERVICE BUREAUS

PLANT PERSONNEL, ENGINEERS, DESIGNERS—Draftsmen, Chemists, and Metallurgists, E. G. Stroud, Member ASME and President of Cleveland Engineering Agency Co., 2132 E. 9th St., Cleveland 15, Ohio, will help you find positions or men.

ENGINEERS AND EXECUTIVES—This confidential service for outstanding men who desire positions paying $5000 to $40,000 will develop preliminary negotiations with reputable organizations without risk to present position. For complete details, send experience record and expected salary range. Tomsett Associates, 337 Frick Bldg., Pittsburgh 19, Pa.

**See Advertisements on Preceding Pages**

SALARIED POSITIONS $3,500 to $35,000. We offer the original personal employment service (established 41 years). Procedure of highest ethical standards is individualized to your personal requirements. Identity covered; present position protected. Ask for particulars.
**R. W. BIXBY, INC.**
115 Dun Bldg. — Buffalo 2, N. Y.

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**SALARIED PERSONNEL $3,000—$25,000**
This confidential service, established 1927, is geared to needs of high grade men who seek a change of connection under conditions, assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited.
**JIRA THAYER JENNINGS**
Dept. J., 241 Orange Street, New Haven, Conn.


FOR METERING

**Flow - Level - Pressure**

WHERE

**ACCURACY**
**FLEXIBILITY**
**RUGGEDNESS**

ARE IMPORTANT CONSIDERATIONS

*One of a group of Republic transmitters metering flow and level in a modern chemical processing plant.*

Republic Pneumatic Transmitters are available for measuring flow, liquid level, pressure or liquid density of a wide range of fluids. They employ the force-balance principle to convert these process variables into air pressures which vary proportionally. These air pressures become direct measurements and can be conducted to reading instruments or used as the measuring impulse for the actuation of an automatic controller.

Republic transmitters have a guaranteed accuracy of within 1/2 of 1% of the transmitter range. By making a few minor adjustments or substituting a few small parts, their operation can be easily changed to any desired range between a minimum of 0-0.6" to a maximum of 0-704" of water. Their construction is more like that of a precision machine than of the sensitive instrument they are. Data Book No. 1001 contains complete details — write for your copy.

**REPUBLIC FLOW METERS CO.**

2240 Diversey Parkway, Chicago 47, Illinois

# Your voice in Davy Jones' locker

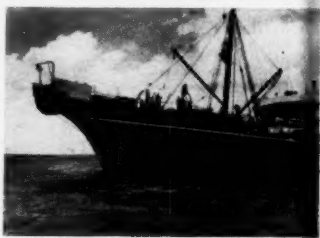
To strengthen voices in the newest submarine cables between Key West and Havana amplifiers had to be built right into the cables themselves. With the cables, these amplifiers had to be laid in heaving seas; and they must work for years under the immense pressure of 5000 feet of water.

For this job, Bell Laboratories engineers developed a new kind of amplifier — cable-shaped and flexible, with a new kind of water-tight seal.

To serve far beyond reach of repair, they developed electron tubes and other parts, then assembled them in dust-free rooms.

The two cables — each has but two conductors — simultaneously carry 24 conversations as well as current to run the electron tubes.

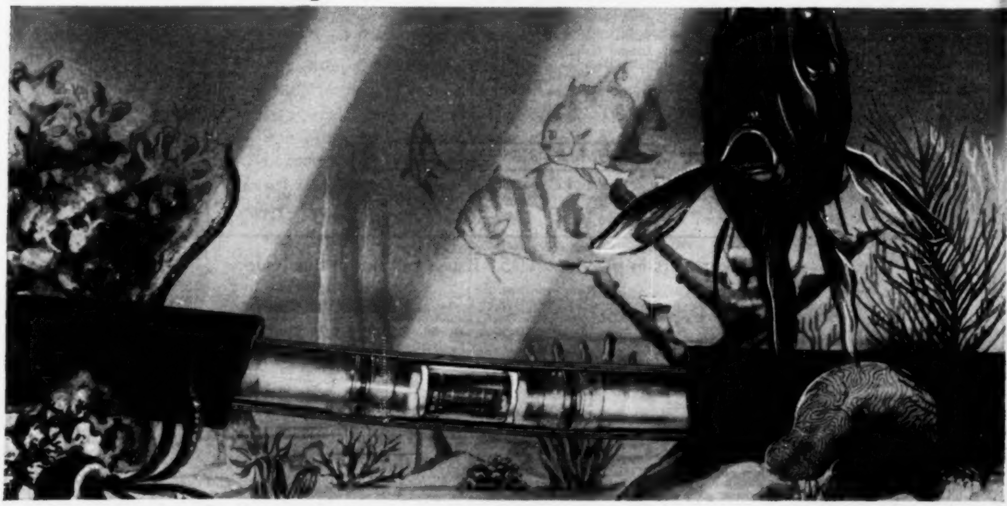
With these deep-sea amplifiers, submarine cables carry more messages . . . another example of how research in Bell Telephone Laboratories helps improve telephone service each year while costs stay low.



*Cutaway view of deep-sea amplifier. Tubes and other elements are housed in plastic cases then enclosed in interleaved steel rings within a copper tube. Layers of glass tape, armor wire and impregnated fiber complete the sheath. Cable ship, shown right, payed out cable over large sheave at bow.*

## BELL TELEPHONE LABORATORIES

*• Exploring and inventing, devising and perfecting, for continued improvements and economies in telephone service.*



# Index To Advertisers

**KEEP INFORMED—Pages 41-64** | **October, 1951** | **OPPORTUNITIES—(classified ads) Pages 126-133**

> *** The asterisk indicates that firm also has product catalog in the 1952 ASME Mechanical Catalog and Directory**
>
> The Only Reference Annual Covering the Mechanical Engineering Field with a Unique Combination of Complete Equipment Directory and Manufacturers' Catalogs. Up-to-date 20-page Insert Catalog of ASME Publications is included. Published Annually.




## CONSULTING SERVICE . . . Page 133



## Advertisers in previous 1951 issues but not in this issue

# New Springfield Universal Grinder offers TIMKEN® "00" bearings for super precision

USERS of vertical grinders who want the utmost in precision are now being offered The Springfield Machine Tool Company's new Vertical Universal Grinders which feature Timken® "Double-Zero" bearings on the work spindle.

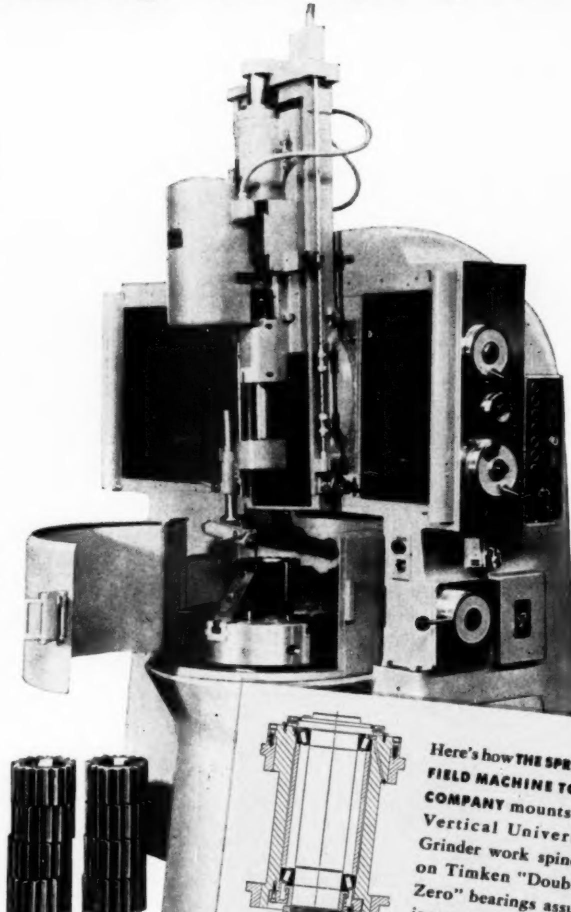
With a maximum run-out tolerance of only 75 millionths of an inch, the new Timken "Double-Zero" bearing is twice as accurate as the Timken "Zero", previously the most accurate Timken bearing ever made.

In order to produce this amazing new bearing, the Timken Company perfected new manufacturing processes and assisted in the development of specialized machine tools and measuring devices of incredible precision. The steel used for the bearings is made in the Timken Company's own mills, providing the correct combination of qualities necessary for super-precision manufacture.

The new "Double-Zero" bearing is the latest example of the Timken Company's leadership in giving industry new standards of bearing precision. In addition to its use in this new vertical grinder, it is already finding a wide field of application on optical dividing heads, gear cutters, lathe spindles and many other machines where extreme accuracy is essential.

Whatever machines you make or buy, the trade-mark "Timken" on the bearings is an assurance of fine bearing quality, long life and dependable performance. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

*This symbol on a product means its bearings are the best.*



Here's how **THE SPRINGFIELD MACHINE TOOL COMPANY** mounts its Vertical Universal Grinder work spindle on Timken "Double-Zero" bearings assuring extreme precision and spindle rigidity.

**WE MAKE OUR OWN STEEL**

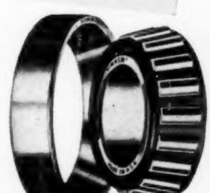
The special grade alloy steel which gives Timken bearings their strength and resistance to wear, is made in our own steel mills.

The Timken Roller Bearing Company is the acknowledged leader in: 1. advanced design; 2. precision manufacturing; 3. rigid quality control; 4. special analysis steels.

**TIMKEN**

TRADE-MARK REG. U. S. PAT. OFF.

***TAPERED ROLLER BEARINGS***



**NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL AND THRUST → LOADS OR ANY COMBINATION**